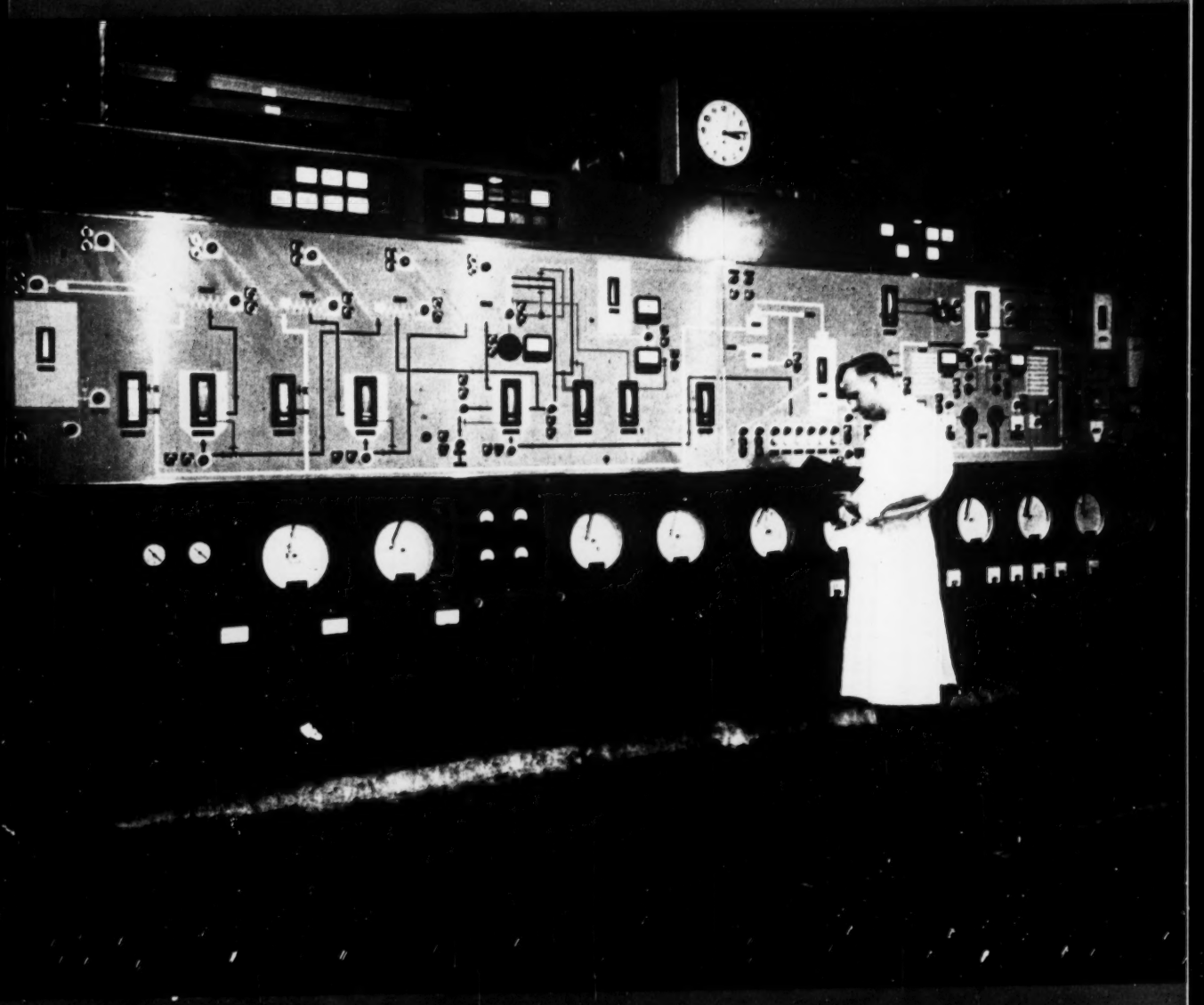
Instruments and AUTOMATION



Complete panel at new paper board mill of American Box Co. *(Photo courtesy of The Foxboro Company. For story see page 662.)*

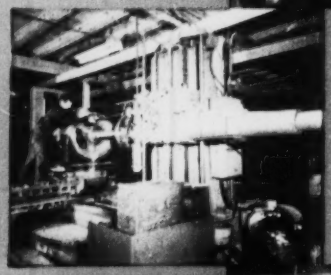
Vol. 27 No. 5
MAY 1954

Here in our Tulsa plant, home of Climax Controls, the Product Development Group translates new concepts of automatic control into final engineering drawings for equipment to meet the precise requirements of tomorrow's Process Industries.

Here's Why BS&B CLIMAX CONTROLS give such *Outstanding Performance!*

Only the most advanced engineering and design...the most modern manufacturing equipment and methods ...the most exhaustive test procedures...and years of practical experience and "know-how" in the industry can combine to produce controls of the quality, precision, long life, efficiency and reliability that you get in Climax! The excellence of BS&B Climax Controls has gained for them a world-wide reputation—for nowhere in the world will you find a better line of automatic process controls...or a company which takes more care and pride in their manufacture! When next you need control equipment for a new installation or for replacement purposes, be sure to specify BS&B Climax...you'll be glad you did!

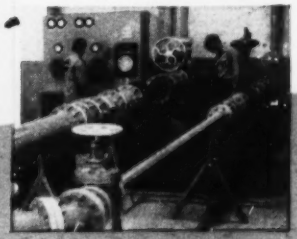
Many different metals are required in the making of Climax Controls. Sizable stocks of steel bars and tubing are maintained in the plant at all times.



A large investment in highly specialized equipment is required to enable us to manufacture Climax Controls in a full range of types and sizes, from the smallest to the largest.

Our skilled machinists and craftsmen take great pride in their ability to turn out consistently fine quality precision work to the customer's most exacting tolerances.

When required, finished parts are heat treated in these precisely controlled electric annealing furnaces—some of the most modern of their kind anywhere in the world.



To assure maximum on-the-job efficiency, every Climax Control must pass rigorous operating tests in one of the industry's most modern hydraulic and experimental laboratories.

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY

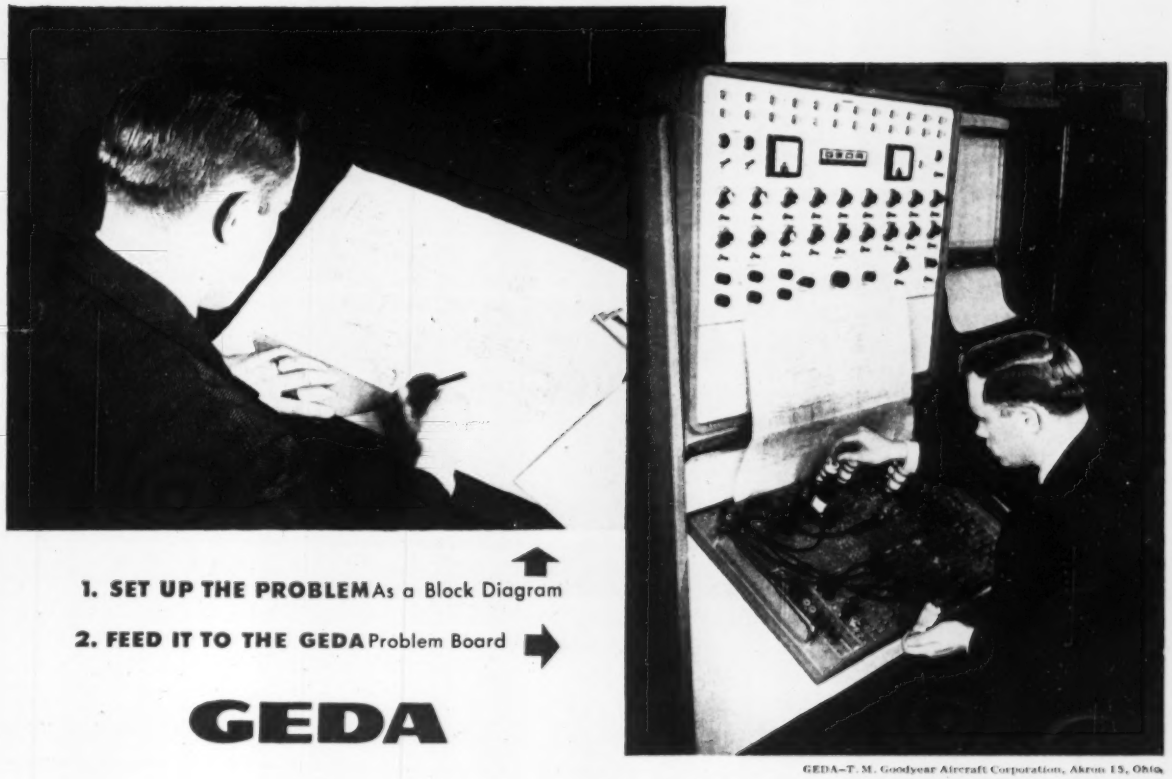
BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V5

7500 East 12th Street Kansas City 26, Missouri

For more information circle 1 on inquiry card.

SIMPLE STEPS TO THE RIGHT ANSWER



1. SET UP THE PROBLEM As a Block Diagram

2. FEED IT TO THE GEDA Problem Board

GEDA

GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

PROBLEMS shrink, time-consuming experimentation is slashed—when the engineer has a Goodyear Electronic Differential Analyzer at his disposal.

He needs no specialized mathematics in order to use it.

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WRITE FOR BROCHURE which describes the complete line of GEDA equipment—including both linear and nonlinear differential analyzers, six-channel console recorder, curve follower and impedence bridge. Address your request, at no obligation, to:

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Dept. 931DR, Akron 15, Ohio.

Give your hunch a chance—with GEDA built only by

GOODYEAR AIRCRAFT

For more information circle **2** on Inquiry card.

DEVELOPMENTS IN LABORATORY INSTRUMENTS

NEW COMPACT DEVELOPER SPEEDS PROCESSING OF OSCILLOGRAPH RECORDS

Now you can develop a 250-foot roll of exposed oscillograph paper records in only 25 minutes . . . virtually eliminate the costly delays normally involved in dark-room processing.

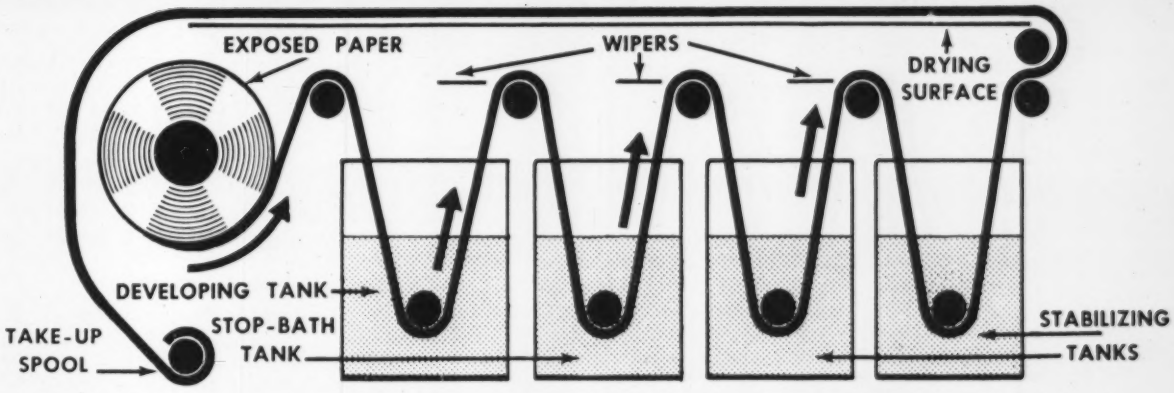
General Electric's newly announced rapid oscillogram developer provides completely dried paper records fast, and . . . . . the unit is portable. This portability means additional time-saving convenience to you!

GENERAL ELECTRIC

GENERAL ELECTRIC ANNOUNCES . . .

New Automatic Processor for Developing Oscillograph Records

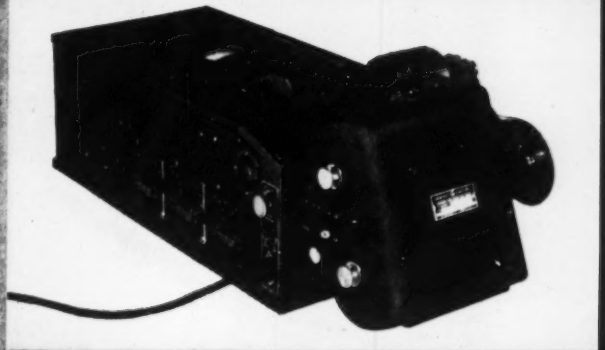
HERE'S HOW THE NEW AUTOMATIC DEVELOPER WORKS!

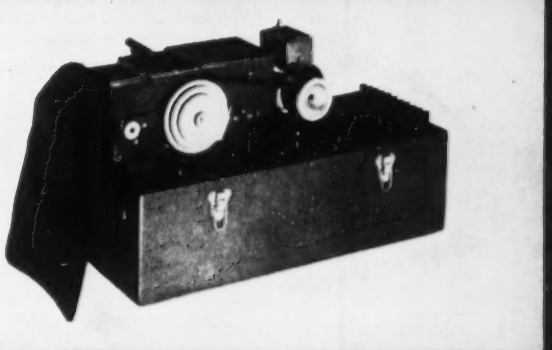


ADJUSTABLE-SPEED DRIVE motor on take-up spool draws exposed linograph paper records through developing stop-bath, and stabilizing solutions, and across the drying surface.

The light-tight, exposed-paper magazine, and rapid oscillogram developer may be operated in daylight. Note that this new unit is designed to process linograph paper, **NOT FILM**.

USE THE NEW DEVELOPER WITH THESE G-E OSCILLOGRAPHS





GENERAL-PURPOSE, Type PM-10 oscillograph offers 12-channel versatility. Simultaneous viewing and recording give added convenience. Records up to about 300 feet per minute.

PORTABLE, Type PM-18 oscillograph is available with 2, 3, or 4 channels. Easy to operate, the PM-18 is recommended for utilities or industrials needing a low-cost, high-quality instrument.

FOR FURTHER INFORMATION simply mail coupon. For helpful facts about a complete line of G-E instruments, check the coupon for Bulletin GEC-1016, "Measuring Equipment Catalog," or contact your nearest G-E Apparatus Sales Office.

SECTION B 605-74, GENERAL ELECTRIC CO.
SCHENECTADY, NEW YORK

Please send me the following bulletins:

- ☐ Rapid Oscillogram Developer (GEC-1232)
- ☐ Type PM-10 Oscillograph (GEC-449)
- ☐ Type PM-18 Oscillograph (GEC-580)
- ☐ Measuring Equipment Catalog (GEC-1016)

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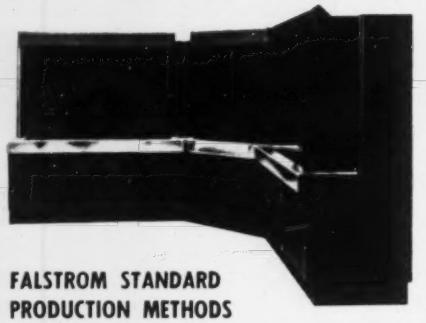
PANELBOARDS & METAL PRODUCTS



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Instruments and AUTOMATION

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By L. K. Spink and W. H. Howe

COVER STORY

Twenty-foot graphic panel, installed in the new paper board mill of the American Box Board Company, Filer City, Michigan, provides complete process instrumentation for the operation of two Chemipulper continuous digesters, refining and blow heat recovery systems, and screw press washing system. Supplementing the panel-mounted control instruments and push-button operating devices are the conventional recorders and recorder-controllers which provide chart records of important process variables. Graphic panel, using Foxboro "Consotrol" and conventional instruments, was engineered by The Foxboro Company, Foxboro, Mass.

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LEWIS

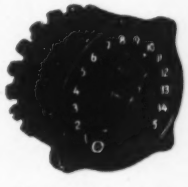
RESISTANCE THERMOMETER AND ACCESSORIES

The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

ACCESSORIES — RESISTANCE BULBS AND SWITCHES

Lewis Selector Switches have been used for years in automotive test work as well as in permanent installations. Simple, sturdy construction plus finest materials combine to give long service.

4" SIZE TO 28 POINTS

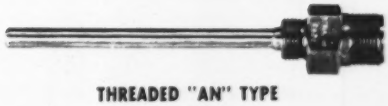


3" SIZE TO 20 POINTS

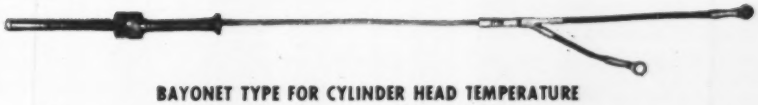
2" SIZE TO 4 POINTS

FREE AIR

THREADED "AN" TYPE



THREADED "AN" TYPE



BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

We invite inquiries on your temperature measuring problems.

THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

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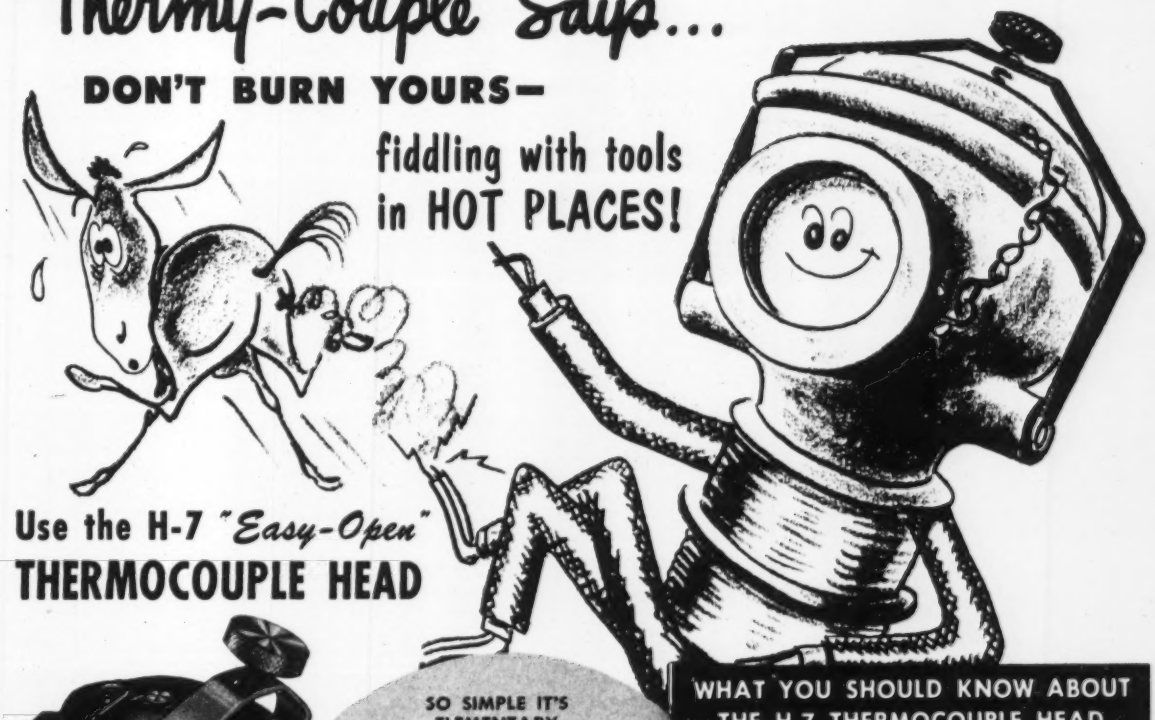
fiddling with tools in HOT PLACES!



Use the H-7 "Easy-Open" THERMOCOUPLE HEAD

The H-7 is an all-purpose thermocouple head that will accommodate *any size* wire whether base metal or platinum. It fits all standard protection tubes with threaded fittings, metal or porcelain.

Available in 1", ¾" or ½" standard pipe thread thermocouple openings. ¼" conduit lead wire opening.

Materials and Craftsmanship of highest quality ... and Our Prices are Lower!

WHAT YOU SHOULD KNOW ABOUT THE H-7 THERMOCOUPLE HEAD

- It is moisture-proof, rust-proof and non-corrosive.
- Gas tight and heat resistant.
- Light weight and compact.
- One-piece Thermocouple assembly *snaps out, snaps in.*
- Stainless steel cover—Cast aluminum base.
- Asbestos gasket (stays in place).
- Cover chained to base.
- Polarity marks plainly marked.
- Millions Now in use.
- This Super Head is lower in price than ordinary Heads.
- Immediate delivery, any quantity.
- Molded transite connector block.

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AND SUPPLY COMPANY

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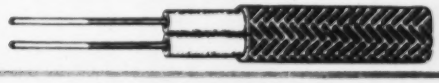
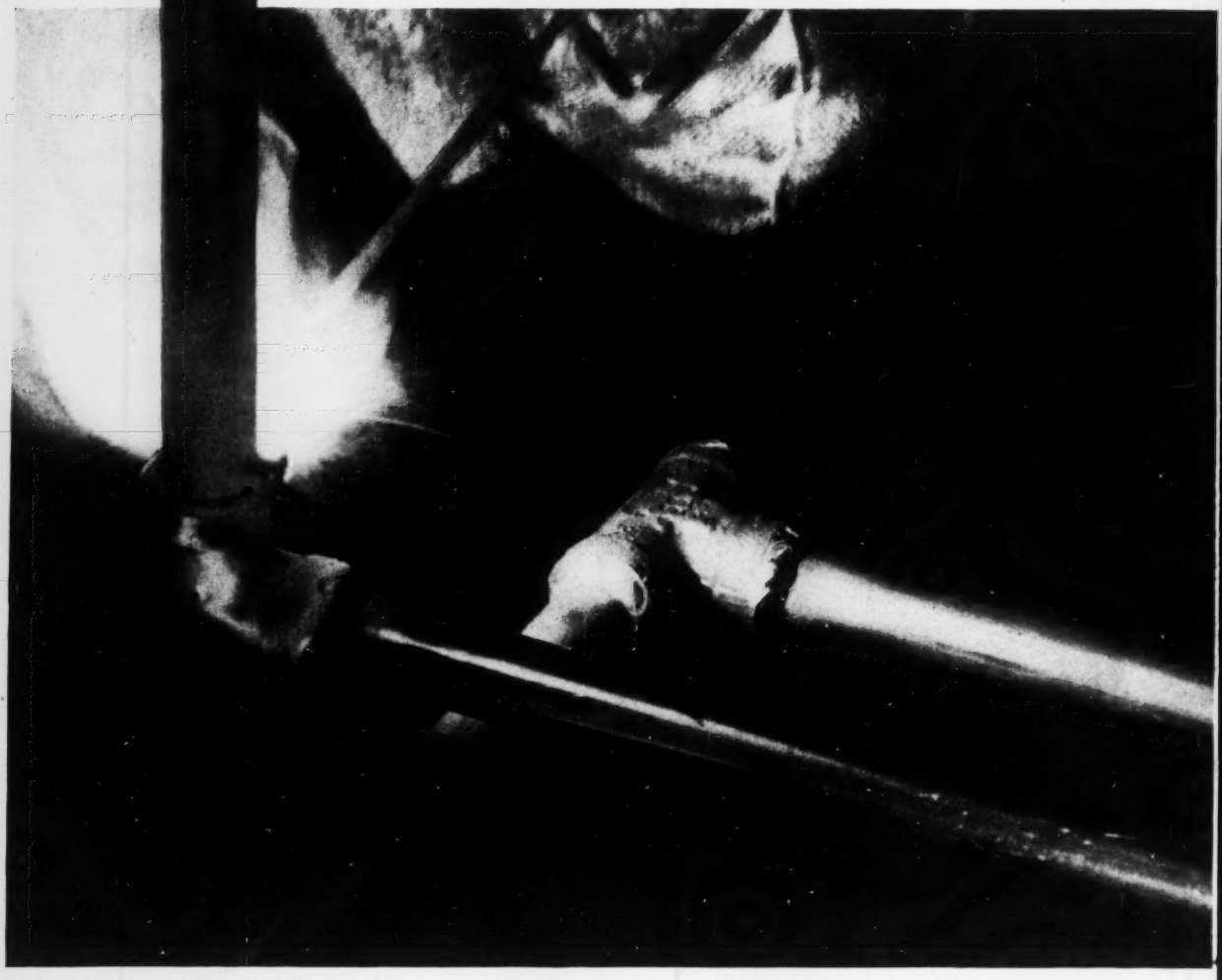
World's Largest ACTUAL MANUFACTURER OF PYROMETER AND THERMOCOUPLE EXTENSION LEAD WIRES.

Also Protecting Tubes and Insulators.



Announcing Parker



Simply insert tube, then weld! No wonder the new Parker *Weld-lok* fittings are so easy to use . . . by anyone anywhere. You don't need special fixtures or equipment to make a fused joint that will be unaffected by vibration, shock or thermal distortion. These new *Weld-lok* fittings are now offered for tubing sizes of ¼ through 2 inches outside diameters.

CALL YOUR NEAREST DISTRIBUTOR FOR PARKER INDUSTRIAL FITTINGS

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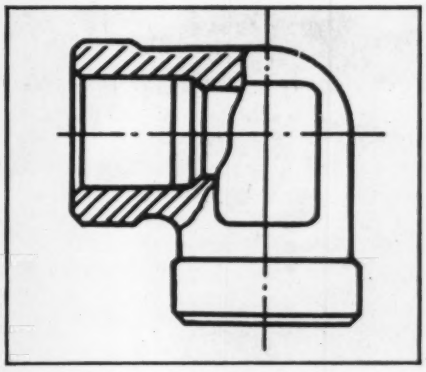
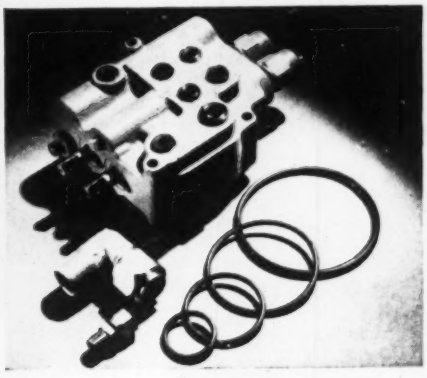
Weld-lok tube fittings

. . . machined from high-quality bar stock and forgings . . . for tubing ¼ through 2 inches O.D.



Cutaway view shows details of the simple *Weld-lok* design which makes *Weld-lok* fittings easy to use. They are steel or stainless steel.



What other Parker products interest you? *Triple-lok* flare tube fittings? *Ferulok* flareless fittings? Hydraulic control valves? O-rings?

Simply push the tube in the socket, then weld! That's how easy it is to install Parker's new *Weld-lok* fittings for tubing. They're designed for applications involving extreme temperatures, corrosion conditions, or wherever permanently welded tubing joints are needed.

Weld-lok fittings have a tapered socket that aligns and holds the tube while you weld. You don't need special gripping fixtures. During welding, extraneous material can't enter the flow passage to form an obstruction. The carefully designed wall section of the fitting induces just the right amount of heat penetration for a correctly proportioned weld.

When you use Parker *Weld-lok* fittings, you get a sturdy, permanently tight line . . . unaffected by vibration, shock, or thermal distortion. Also, the inside diameter of the fittings closely matches the inside diameter of tubing to provide free flow passage.

All commonly used connectors and body shapes are now offered for tubing sizes of ¼ through 2 inches outside diameters . . . steel or stainless steel.

Ask your Parker distributor for *Weld-lok* Catalog No. 4370. Then, to order, simply use the complete part number designated for each fitting. It indicates size, shape and material.

TUBE AND HOSE FITTINGS DIVISION
The Parker Appliance Company
Section 406, 17325 Euclid Avenue, Cleveland 12, Ohio

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Tampa, Fla.	Florida Metals, Inc. 222 N. 12th St.
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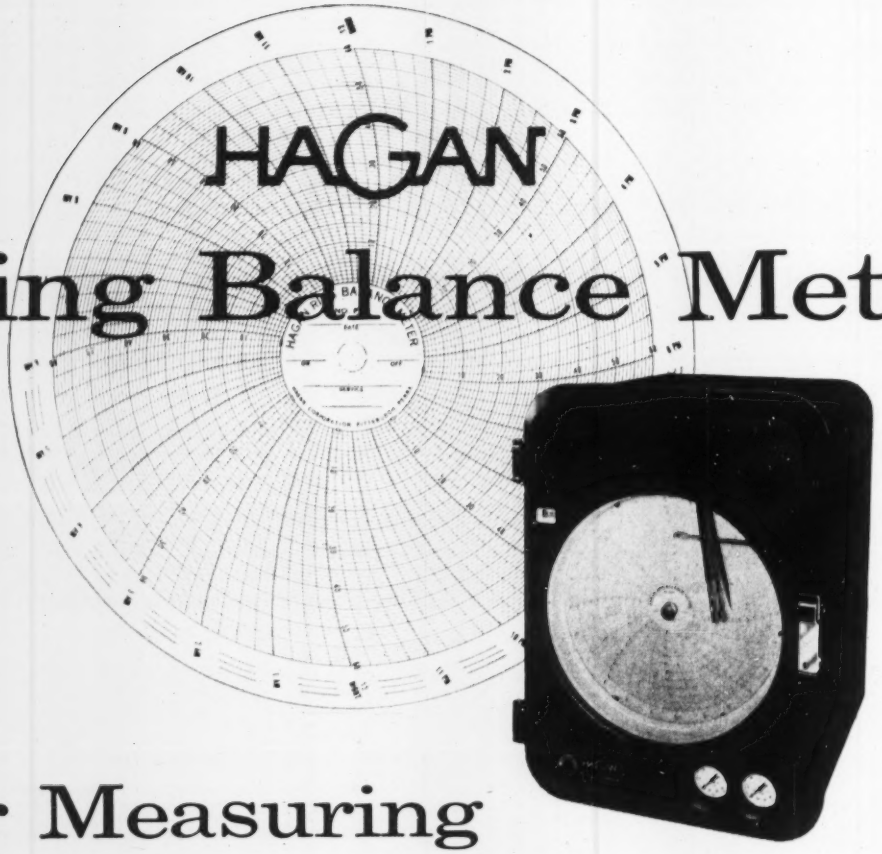
For more information circle 7 on inquiry card.

HAGAN

Ring Balance Meters



for Measuring Low Full Scale Differentials

The necessity for measuring flows, with only a low full scale differential available, may result from any of several factors. Type and location of the source of differential, or lines oversize for the flow rate, are encountered most frequently.

The Hagan Ring Balance Meter is particularly adapted for accurate operation at full scale differentials as low as 1″ WC, with any type of primary element—venturi tube, weir, flume, orifice plate or flow nozzle.

For such services, the Hagan Ring Balance Meter has these advantages:

- There is a complete series of interchangeable sensing elements for full scale differentials from 1″ to 420″ WC at static pressures up to 3000 psig.
- Ring assemblies are always selected to have ample power at all flow rates.
- The differential measuring range of any ring is adjustable over 7 to 1 range.
- Dead weight check of calibration takes only a few minutes. It is not necessary to disconnect the meter from the line.
- Automatic compensation for such factors as fluid density, pressure and temperature is a standard attachment.
- Pneumatic or electric transmission is available for remote recording or for automatic control.

Hagan engineers are prepared to suggest the instruments best suited for new construction or modernization and extension of existing facilities.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PENNSYLVANIA

Boiler Combustion Control Systems, Ring Balance Flow and Pressure Instruments, Metallurgical Furnace Control Systems, Control Systems for Automotive and Aeronautical Testing Facilities

For more information circle **8** on inquiry card.

a valve that never blows its top

All K & M diaphragm Control Valves have a drawn steel diaphragm casing able to withstand extreme heat, impact, pressure and shock . . . and a cast steel open yoke that retains its strength when the heat is on. When something goes wrong, the difference between safety and danger might very well be this all steel construction.

Further, consider the everyday advantages of the all steel K & M construction: One man can move the smaller size valves without hoists, for the K & M steel topworks weighs only half as much as other topworks of equal size. The open yoke, provided in cast steel by *only* K & M, assures accessibility and completely eliminates any possible accumulation of gas, vapor or condensate.

More linear . . . more accurate . . . more responsive

The K & M molded neoprene diaphragm provides a large effective area which is constant throughout the long stem travel. Thus, K & M Diaphragm Motors provide maximum linearity in stem movement and virtually the highest power factor available. Operating with high capacity, low turbulence K & M valve bodies, these motors mean more accurate, more responsive flow regulation.

For Complete Automatic Control Valve Data: Write for your copy of the new K & M Valve Engineering Data Catalog, Bulletin CV53. Also Available . . . New Valve Size Calculator with Low Flow Data.

K&M

Valve Makers
Since 1879

diaphragm control valves

KIELEY & MUELLER, INC.

64 Genung Street
Middletown, New York

For more information circle 9 on inquiry card.

PYROTRON
by BAILEY...

Your best buy for Precision Temperature Measurements In the -300F to 1200F Range

Check These Exclusive Bailey Advantages of Resistance Thermometer Operation

✓ Resistance thermometer operation over a complete range from —300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

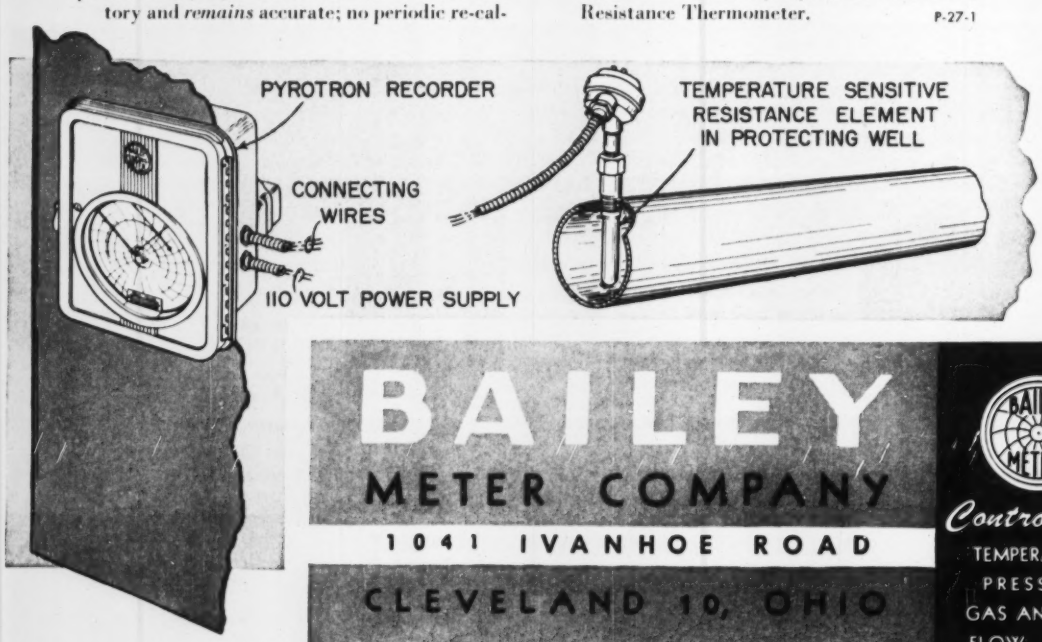
✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Recorder is sensitive to 1/10 of 1% of range span.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



BAILEY METER COMPANY

1041 IVANHOE ROAD

CLEVELAND 10, OHIO

Complete Controls for Process Plants

BAILEY METERS

Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

For more information, circle **10** on inquiry card.

ELECTRONIC TEST INSTRUMENTS

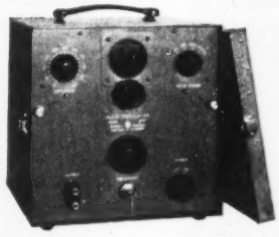
TEST VOLTAGE PROBLEMS 1/100 cps to 10 mc?

Hewlett-Packard has 17 different oscillator models. Some are highly specialized, others are all-purpose instruments. Almost certainly, there's a model to meet your exact requirements. All are precision instruments of highest quality. All embody the famous RC circuit pioneered by *-hp-*. Check the table below for the oscillator that can help you most. Then write us for complete operating and application details.

-hp- 200CD AUDIO OSCILLATOR

World standard for electronic or electrical measurements, now redesigned with wider range, lighter weight, smaller size. Use for any lab, field or production problem in subaudio, audio, telephony, carrier, supersonic, telemetering or rf measurement fields. Highest stability, low distortion, constant output, no zero set while operating. With carrying strap for bench or portable use; or for rack mounting.

Instrument	Primary Uses	Frequency range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 kc	1 watt 24 5v	$120.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 kc	160 mw 20v open circuit	150.00
-hp- 200H	Carrier current, telephone tests	60 cps to 600 kc	10 mw 1v	350.00
-hp- 200I	Interpolation, frequency measurements	6 cps to 6 kc	100 mw 10v	225.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3w 42 5v	250.00
-hp- 202A	Low frequency measurements	.01 cps to 1 kc	20 mw 10v	450.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw 10v	350.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw 10v	275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2 5 mw 5v	175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	390.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	425.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	550.00
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 kc	15 dbm	550.00
-hp- 230A	Carrier test oscillator	35 cps to 35 kc	14 dbm 600 ohms	275.00
-hp- 233A	Carrier test oscillator	50 cps to 500 kc	3w 600 ohms	475.00
-hp- 234A	Carrier test oscillator	160 cps to 160 kc	14 dbm 600 ohms	300.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw 3v	475.00



-hp- 204A Battery-Operated Oscillator

Precision instrument for measurements 2 cps to 20 kc where ac power is not available. Compact, light weight, weather-proofed—extra rugged construction for field duty. Frequencies set and read directly on large dial. Particularly useful for telephone or remote broadcast line checks, strain gauge applications, telemetering and geophysical measurements. Provides completely hum-free signal. Operates from flashlight and 45-volt batteries. Output stable and constant throughout range.

-hp- 650A Resistance-Tuned Oscillator

Highly stable, wide band (10 cps to 10 mc) oscillator particularly useful for testing television amplifiers, receiver alignment, bridge or carrier circuits, wide band systems; determining tuned circuit response. Operates independently of line or tube changes, requires no zero setting. Output flat within 1 db throughout range, monitored with VTVM. 60 db attenuator adjusts in 10 db steps.

-hp- 202A Low Frequency Function Generator

Compact, convenient, all-purpose source of transient-free voltages between 1/100 cps and 1 kc. Provides distortion-free signals for vibration studies, servo applications, medical and geophysical work and other subsonic problems. Generates sine, square or triangular waves. Output 10 v RMS, balanced or single ended, 1% distortion, constant within 0.2 db.

Data subject to change without notice. Prices f. o. b. factory

HEWLETT-PACKARD COMPANY

2711C PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

SALES REPRESENTATIVES IN PRINCIPAL CITIES

Export: Frazar & Hansen, Ltd., New York City, San Francisco, Los Angeles

Instruments for Complete Coverage

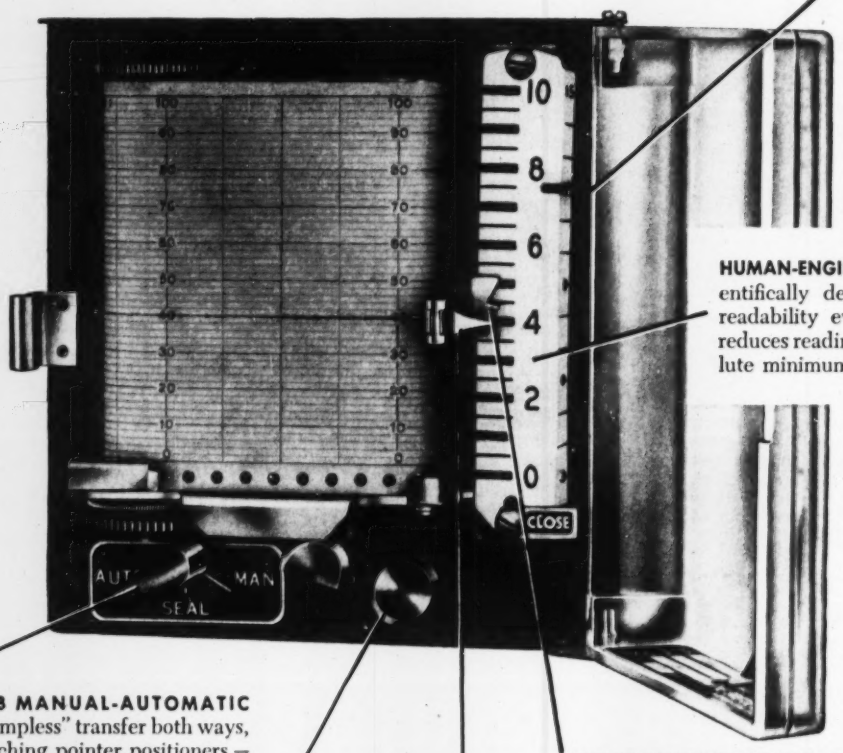
For more information circle 11 on inquiry card.

WHAT'S NEW AT BRISTOL . . . .

BRISTOL'S METAGRAPHIC* RECORDERS

with CONTINUOUS VALVE-POSITION INDICATION

*** Separate from set-point indication * Gives continuous data on control valve position and level of process operation * No switching to get reading**



HUMAN-ENGINEERED SCALE, scientifically designed for instant readability even at a distance, reduces reading errors to an absolute minimum.

SINGLE-KNOB MANUAL-AUTOMATIC TRANSFER. "Bumpless" transfer both ways, simply by matching pointer positioners – no need to read actual scale values –minimizes reading errors – speeds operation.

CONTINUOUS SET-POINT INDICATION. Shape and color of set-point target make it easy to see at a glance when process is on or off the control point. Rapid scan deviation indicator.

SET-POINT REGULATOR. High-precision, two-stage, no-drift regulator – high capacity (3 scfm) output for fast manual control in emergencies.

CONTROL VARIABLE RECORDED AND INDICATED. High-visibility pointer (fluorescent paint) for accurate reading at a distance.

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

*** Bristol *Metagraphic* Pneumatic Transmission Instruments measure, indicate, record, and control pressure, temperature, vacuum, flow, differential pressure and liquid level. Write for bulletin. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.**

4.6

BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **12** on inquiry card.

Trends...

Late News and Comments

Titanic struggle for leadership is being waged in auto industry. All manufacturers are increasing use of automation equipment to reduce unit cost. Companies have no choice—only those who reduce production costs can stay in business in today's competitive market.

Will automation hurt labor? The new Ford plant at Brookpart Village, Ohio, uses 3 machines and 10 men to do the work of 29 machines and 40 men. But the Ford Brookpart plant increased the total number of jobs in the Cleveland area by 8000.

Industrial use of radioactive products is accelerating. List now includes sterilization, pasteurization, and enzyme control; insect and fungus control; ionization of gases for static elimination and static particle precipitation; chemical use in polymerization, halogenation, oxidation, and molecular rearrangement; radiography; therapeutic radiology; industrial instruments for thickness, density, and level; tracer studies; and others. Industrial market should be No. 1 on promotion list of nucleonic-instrument companies.

Tracer techniques are limited only by imagination of users. Caterpillar Tractor Co. of Peoria studies piston wear by using radioactive piston ring, then measuring radioactivity in crankcase oil.

Atomic power plants should supply 2 to 10% of our power needs by 1975, said Henry D. Smyth, USAEC, in a talk on April 23 at University of Chicago. This assumes that costs of conventional fuel do not change appreciably. However, other nations may use atomic power more readily and economically; cost of conventional (steam or hydroelectric) power in Japan is 20 mills/kwh., cost in U. S. is only 4 to 7 mills/kwh.

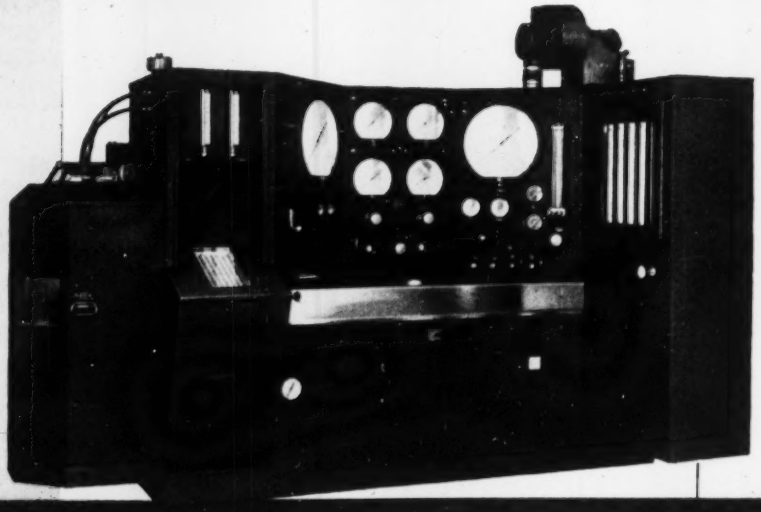
"Trend to highly skilled personnel working with elaborate devices is causing services of each employee to be worth more," said Dr. R. C. Page in a talk on April 27 at the convention of the Industrial Medical Association. This will be reflected by greater emphasis on worker health by corporation management.

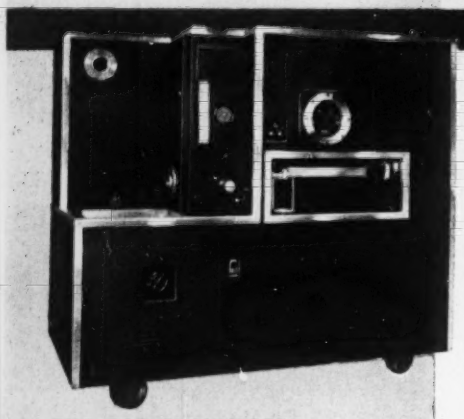
Translating machines are new field. Problems in syntax are being investigated by electronic engineers and linguists. IBM and Georgetown University recently revealed translation of Russian sentences by "Type 701" calculator.

World's most modern instrument plant is in plan stage by Leeds & Northrup; 250,000-square-foot building will cost in excess of $4 million. Servomechanisms, Inc., states in 1953 Annual Report that "1953 net sales rose to a new high of $13,332,746, an increase of about 30% over the previous year." Exact Weight Scale Company reports that current business is running well ahead of the same period last year.

COX TEST STANDS

STAND THE TEST OF TIME!





THE 309 FLOWMETER CALIBRATING STAND

More precision flowmeters are calibrated and checked on Cox Calibrating Stands of which the Type 309 is the latest, than on any other stand used by the automotive and aircraft industries. A precision-weighing mechanism weighs the flow through the flowmeter being tested, assuring precise calibration of the instrument. Portable Cox Calibrating Stands will accommodate single or multiple stage flowmeters of any make.

TYPE 416 UNIVERSAL FUEL NOZZLE TEST STAND

Used by the aircraft industry to test for optimum efficiency of jet fuel nozzles, this highly accurate Cox Test Stand is a "complete modern hydraulics laboratory." Pressure, temperature, and flow rate can be controlled during testing to simulate the actual conditions under which jet fuel nozzles normally operate in the engine.

• When automotive and aircraft manufacturers first encountered the problem of determining in advance how certain engine accessories would perform under actual operating conditions, Commercial Research Laboratories engineers developed special test stands which would supply this information.

To test for optimum efficiency of jet fuel nozzles, for example, the nozzle is mounted in a Cox Nozzle Test Stand in which temperature and pressure are controlled and fuel is passed through the nozzle at the rate required. The fuel is automatically weighed by an electronic weighing device within the test stand and from this information the nozzle rate of flow is computed.

Cox precision-weighing Calibrating Stands are equally indispensable to automotive carburetor testing since the flowmeters which are used to measure the exact flow rate must themselves be calibrated and regularly checked on these portable, highly accurate stands.

Despite the difficult tasks these and other Cox test stands are called upon to perform in helping industry to solve complex testing problems, they have built up an outstanding record of many years of dependable service and performance.

Other CRL *Products*

- **Single and Multiple Stage Flowmeters**
- **Engine Indicators**
- **Magnetic Thickness Gages**
- **Balanced Electronic Equipment for Measuring Pressure and Vibrations**
- **Vibration Study and Recording Equipment**

Write us for descriptive literature and complete details on these and other Cox Test Stands — including Air Flowmeters and Carburetor Flow Stands.

Commercial Research Laboratories, Inc.

20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

Makers of REGISTERED TRADE MARK ***Since 1912***

For more information circle **13** on inquiry card.

PRECISION PRESSURE MEASUREMENT

of Gauge Pressure, Vacuum or Differential Pressure

Precision Dial Manometer Type FA-145

Accuracy:
1 part in 1000 over full scale.
Sensitivity:
1 part in 10,000 in *all* ranges.
Ranges:
0 to 120 inches of water (min.)
0 to 250 inches of mercury (max.)
Other intermediate ranges available.
Scale Length:
45 inches.
Dial Diameter:
8½ inches.

Precision Low Pressure Gauge Type FA-141

Accuracy:
1 part in 300 over full scale.
Sensitivity:
1 part in 500 in *all* ranges.
Ranges:
0 to 10 inches of water (min.)
0 to 400 inches of water (max.)
Other intermediate ranges available.
Scale Length:
7 or 16 inches.
Dial Diameter:
2¾ or 6 inches.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST. BELLEVILLE 9, N. J.
In Canada Wallace & Tiernan, Ltd., Toronto

For additional data, write for Publication TP-30-A and TP-27-A

A-101

For more information circle 14 on inquiry card.

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Ionic Pump

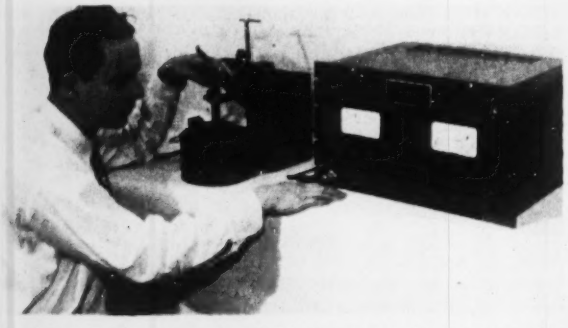
SCHENECTADY, N. Y.—Two General Electric scientists have built a simple experimental air pump, with no moving parts, which can produce a vacuum as high as one billionth of normal atmospheric pressure, similar to that in X-ray tubes and TV picture tubes. Consists of a circular stainless-steel box, about two inches in diameter and an inch thick. The box is supported between the poles of a powerful Alnico permanent magnet, and is connected by means of a tube to the vessel from which gas is to be exhausted.

Rough exhaustion of air to about one one-hundred-thousandth of an atmosphere is accomplished with an ordinary mechanical pump. Then a valve is opened, to connect the ionic pump with the vessel, and the current is turned on.

Electrical forces ionize the gas atoms, which are pulled toward carbon plates on the pump walls, which are negatively charged. On the way, the ions hit the carbon plates and are driven into them, where they are held. Since they are removed from the open space, gas pressure is reduced. Many cubic centimeters of gas can be absorbed by the carbon. The ionic pump works on practically all gases.

Vibration Pickup Calibrator

WASHINGTON, D. C.—An instrument which calibrates vibration pickups and accelerometers rapidly and reliably has been devised by W. A. Yates and M. Davidson of the National Bureau of Standards. At the left of the chassis



is the transducer probe which is mounted on a massive block to reduce ambient vibrations. Switch settings on the panel at right provide measurement of four displacement ranges with full-scale readings of 0.01, 0.001, 0.0001 inch and 10 microinches, and an accuracy of five percent over a frequency range of 10 to 20,000 cps. This is an acceleration range of 2×10^{-4} to 4×10^{5} g.

The instrument is standardized by chopping the detected d-c. voltage increment produced by a standard mechanically measured displacement change (0.02 inch) into a square wave. Fed into the same a-c. peak-to-peak voltmeter on the 0.01-inch range, the square wave is equivalent to a 0.01-inch peak amplitude of vibration. The sensitivity of the voltmeter is then adjusted to obtain a full-scale reading.

Process-control Computer

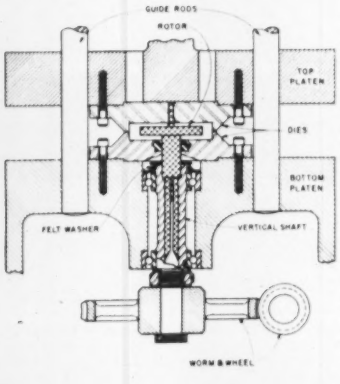
WASHINGTON, D. C.—Five Du Pont scientists have used the big electronic "brain" at The Massachusetts Institute of Technology to operate, on paper, a chemical reactor in a company plant hundreds of miles away. So well did the brain do its work, the scientists said, that they were able to establish a set of operating conditions for the reactor that resulted in a 25-percent increase in production rate.

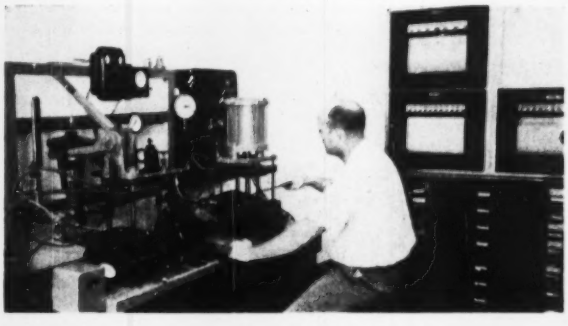
The production problem solved by the scientists and the robot was created by a pile-up of coke-like material on the walls of the reactor during operation, a development which caused the reaction temperature to rise above levels needed for efficient equipment performance. In effect, the scientists asked the computer to give them the temperatures, pressures, and other reaction variables for a whole range of flow-rates. In several cases, the computer answered with figures for heat and pressure which clearly were those for a reaction so violent as to have blown up the reactor, if not the entire plant.

In getting their answers from the computer, the scientists converted their equations into simple arithmetic problems, translated these into a code and punched the code out on a tape which was fed into the computer.

NBS Studies Mooney Viscometer

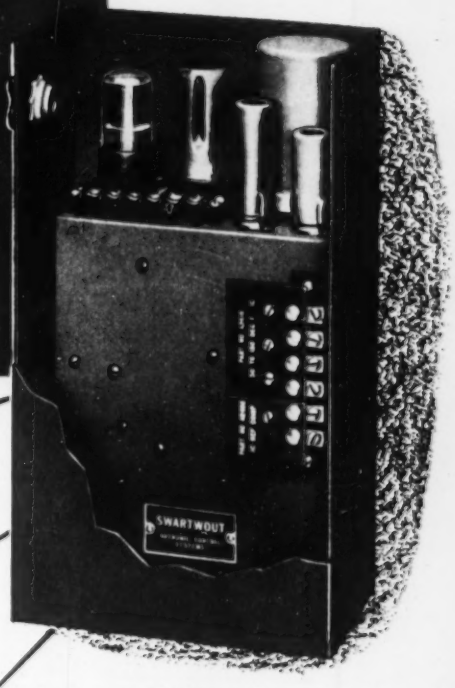
WASHINGTON, D. C.—Recent investigations at the National Bureau of Standards have led to a better understanding of the utility and limitations of the Mooney viscometer—an intrument widely used for quality control in synthetic rubber production and in rubber processing. G. E. Decker and F. L. Roth have developed designs for the viscometer rotor and dies which provide improved dimensional stability, better heat-transfer characteristics, and greater uniformity of results. The Mooney viscometer, invented in 1933 by Melvin Mooney of the United States Rubber Company, consists of a disk rotating in a shallow cylindrical cavity filled with the rubber under test. The rubber is squeezed into the cavity under considerable pressure. The surfaces of the disk, or rotor, and of the dies which form the cavity are serrated in a grid pattern to grip the rubber mechanically. The force required to rotate the rotor at a constant rate—ordinarily 2 rpm.—is meas-

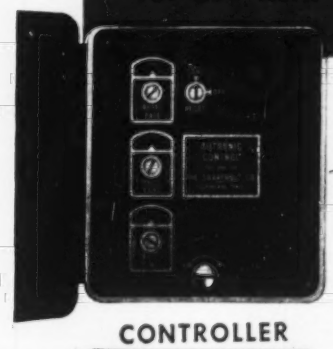




ANNOUNCING...

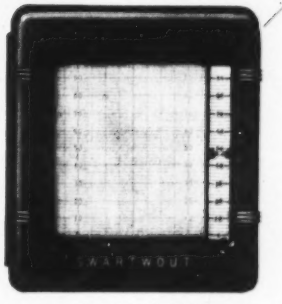
THERMOCOUPLE CONVERTER





CONTROLLER

INDICATOR



RECORDER

Exhibited for the first time at the recent Chicago Instrument Show, the Swartwout Autronic Thermocouple Converter is now in production. Designed primarily for use with components of the Autronic system, it is a high impedance all-electronic null-balance unit which does not draw current from the thermocouple. D-c millivolt signals are converted to 0.000-0.500 volt a-c. Range is easily and quickly converted by changing range cards. There are no pilot valves, flappers or other troublesome parts. Operation is instantaneous, maintenance virtually eliminated.

CONDENSED SPECIFICATION DATA

SPAN: 2 to 50 millivolts
ZERO SUPPRESSION: −10 to +50 millivolts
SPAN ACCURACY: ½%
SUPPRESSION ACCURACY: 0.1%
REPRODUCIBILITY: ¼%
SENSITIVITY: 0.1%
REFERENCE JUNCTION COMPENSATION: Automatic—Removable card for different thermocouple materials
SPAN AND ZERO ADJUSTMENT: Replaceable range card
REFERENCE VOLTAGE: Standard cell
INPUT IMPEDANCE: Null-balance—draws no current
OUTPUT VOLTAGE: 0.000 — 0.500 volts, 60 cycles a-c
CASE: Surface mounting

Other Swartwout a-c and d-c converters are available for use with primary elements such as pH, oxygen, strain gage, electronic flowmeter, cascading, ratioing, etc. Literature and information available on request to Swartwout representatives or to the plant. A-1511

Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **15** on inquiry card.

EPLAB

PYRHELIOMETER
For the Measurement of
SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.
Newport, Rhode Island U.S.A.

For more information circle 16 on inquiry card.

ured by deflection of a calibrated spring and is proportional to the mean viscosity of the rubber in arbitrary units. The viscosity is obtained at an elevated temperature, generally 212 deg. F., the instrument being heated either by steam or electricity.

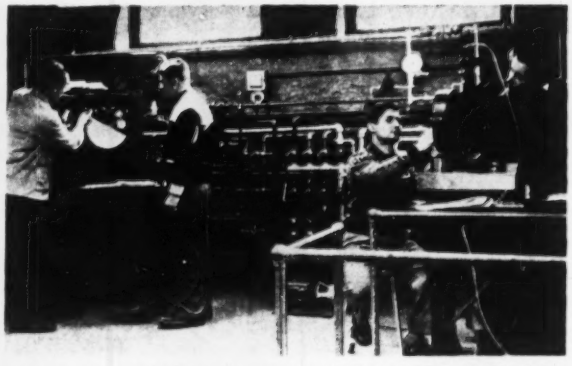
Telemetering at Northeastern Gas

SPRINGFIELD, MASS.—The Northeastern Gas Transmission Company, Springfield, recently completed installation of a complete telemetering system by which a dispatcher at a central instrument panel is kept constantly informed of conditions in all parts of the gas distribution lines.

Northeastern receives its gas from the Tennessee Gas Transmission Company at West Lebanon, N. Y. Three measurements of gas flow and two of pressure are made at this point and transmitted by Bristol Metameter telemeter transmitters to Springfield, 85 miles away, over a single leased telephone circuit. Remote adjustment of the control point on the automatically-controlled valves at West Lebanon can be effected from Springfield.

Instrument School

HARTFORD, CONN.—The Ward School of Electronics, a division of Hillyer College, Hartford 7, Conn. uses an



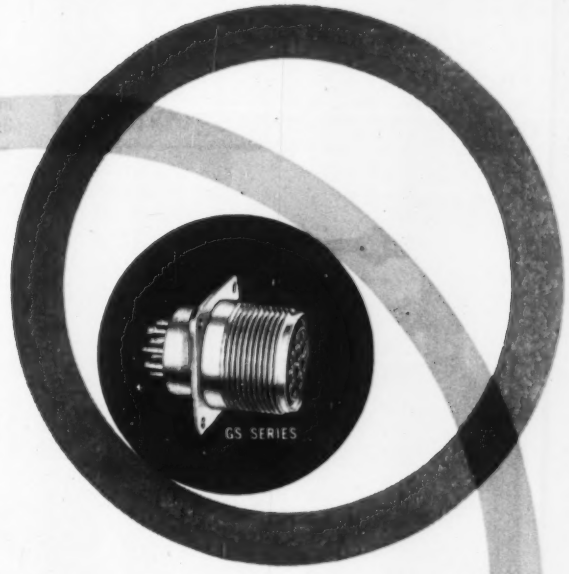
extensive manifold and many models of industrial flow controllers to teach its students about ratio and flow control.

Iron & Steel Instrumentation

BUFFALO, N. Y.—John Green, steel-industry manager for Industrial Division of Minneapolis-Honeywell Regulator Co., reports that in a study of more than 100 regenerative soaking pits in 10 different plants, it was found that heating time was reduced 30 percent, that heating was more uniform, and that an increase in available heating area of 20 percent resulted in an increase in capacity of 50 percent in controlled pits. Pit life is extended at least 50 percent; controlled pits work at 90 percent of efficiency after three years' service, whereas capacity of uncontrolled pits is off 30 or 35 percent.

Ultrasonic Inspection Film

DANBURY, CONN.—"Ultrasonic Inspection," a ten-minute sound-color educational film describing the development, theory, operation and application of the Sperry Ultrasonic "Reflectoscope" for non-destructive testing of



for **TRUE**

HERMETIC

SEALING

connect with cannon!

Hermetically-sealed multi-contact connectors made by Cannon are really rugged! And . . . they are the only connectors that give you **true hermetic sealing under such adverse pressure and atmospheric changes.** Here's why . . .

Cannon pioneered the first successful hermetically-sealed connector more than six years ago . . . since then has continuously refined and increased the line. All have special steel contacts. Vitreous insulation . . . **fused to both contacts and shell for a perfect permanent seal** . . . is stronger than steel, withstands temperatures to 600° F, and permits the use of the **highest conductive steel** contacts compatible with any vitreous fusing operation.

Available in a wide variety of insert layouts for control, relay, power, and instrument applications in Series GS, (AN type), KH, RKH, U, DAH, BFPH, TBFH, DBH, DCH, KOH, standard, miniature and sub-miniature sizes. Also, special mounting flanges and brazing service to help you obtain a strong and leakproof overall assembly.

CANNON PLUGS

DH SERIES

U SERIES

RH SERIES

Please refer to Dept. 180

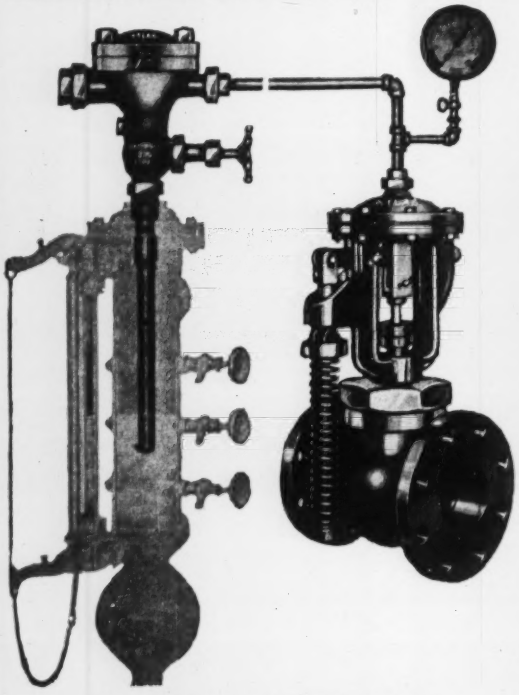
CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California

Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
Representatives and distributors in all principal cities are at your service.

first in connectors

For more information circle **17** on inquiry card.

CAMPBELL
Boiler Feed Water Regulator



6 REASONS
why boiler operators, the world over, continue to specify the CAMPBELL

1—Continuous Blowdown;
2—No Moving Parts;
3—No Thermostats;
4—No Floats;
5—No Links;
6—No Generators.

The CAMPBELL maintains a constant water level when the load is steady.

Compensates quickly for momentary changes in water level caused by sudden increase or decrease in steam demand.

Nothing to get out of order or require adjustment. As easily installed as cutting a valve in a pipe line.

For complete information ask for Bulletin 8-A.

Other ATLAS Regulating Devices: Reducing Valves; Damper Regulators; Temperature Regulators; Exhaust Control Systems; Back Pressure Valves; Float Valves; Pressure Regulators; Pump Governors; Balanced Valves; Control Valves; Oil Control Cocks; Etc. ATLAS has been in the regulating valve business *exclusively* for more than a half century.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
292 South Street Newark 5, New Jersey
Represented in Principal Cities

For more information circle **18** on inquiry card.

ON THE MARCH—CONTINUED

metals and other materials, has just been released by Sperry Products, Inc., of Danbury, Connecticut.

Prints of the film are available for showings to interested industry, trade and technical groups as well as technical and engineering societies, schools and colleges.

Research Safety

NEW YORK, N. Y.—As he transfers chemicals to a vacuum system for filling Geiger counters, a New York University Engineering Research Division aide wears acid-

resistant "ChemKlos" and an industrial gas mask, both developments of Mine Safety Appliances Company, Pittsburgh. Safety dictates use of such special clothing and breathing protection in handling the variety of chemicals and gases employed in research activities.

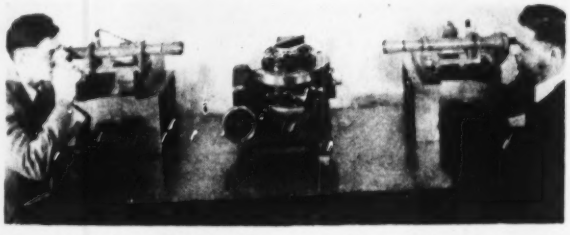
Most Powerful Accelerator

WASHINGTON, D. C.—The world's most powerful particle accelerator, the University of California Bevatron, has gone into successful operation. The machine has accelerated protons, the nuclei of hydrogen atoms, to an energy of 5 billion electron volts (Bev), the highest energy ever achieved by an accelerator. The $9 million machine was built with AEC funds.

Early research will be devoted to identification of nuclear particles generated when protons from the machine smash into target atoms.

Precise Angular Standard

WASHINGTON, D. C.—A 24-sided polygon of exceptional accuracy has been constructed by C. E. Haven and A. G. Strang of the National Bureau of Standards to serve as a basic standard of angular measurement. Made of precisely machined and polished gage blocks accurately positioned

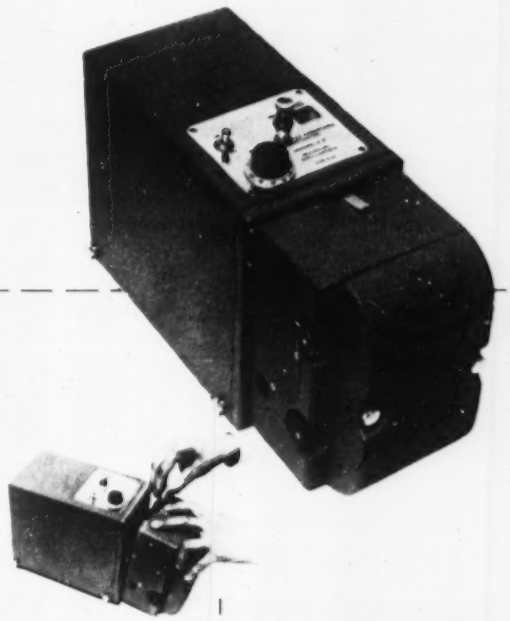


at measured angular intervals on a circular base plate, the NBS polygon permits the comparison of an "unknown" angle with consecutive angular intervals until the total of such intervals equals an integral number of perfect 360-degree angles. The polygon was designed primarily for use

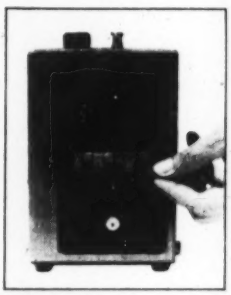
Now you can have high precision dynamic data recording on a limited budget

Priced competitively with inexpensive pen-type recording oscillographs but offering far greater frequency range and improved accuracy, Consolidated's new low cost 6-channel Type 5-117 Recording Oscillograph now takes its place in the CEC precision instrument line. Using CEC's new, improved series 7-300 galvanometers, the 5-117 now brings to industry accurate dynamic measurement which only a precision, photographic type recording oscillograph can provide. The 5-117 Oscillograph produces accurate recordings with flat response over the frequency range of 0 to 300 cps. Galvanometers are available for use in the 5-117 which permit strain gage measurements with flat response from 0 to 90 cps *without amplification*. For full details about this high-precision, low-cost instrument write for CEC Bulletin 1533A-X1.

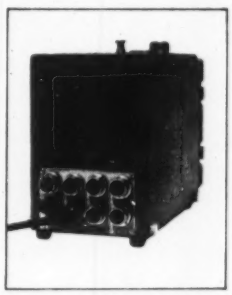
Consolidated's 5-117 Recording Oscillograph



The Consolidated 5-117 Recording Oscillograph features a detachable magazine which accommodates 100 foot rolls of recording paper 70 millimeters wide. An integral footage indicator shows the remaining or unexposed record length. The record is positively driven through change gears, and any one of six speeds from ¾ inch to 24 inches per second may quickly be selected. The CEC Type 5-117 Recording Oscillograph gives you precision dynamic data recording for the price of a pen-type recording oscillograph.



"Spot setting" of six CEC Type 7-200 or 7-300 Galvanometers is made easy by a calibrated ground glass screen brought into position by swinging a pivoted bracket.



Data input from transducers to the oscillograph is through six individual locking-type electric connectors on a rear panel. Integral 6-foot power cable is standard equipment.

Active data channels	6 active and 1 static reference trace.
Galvanometers employed	CEC Type 7-200 or 7-300 magnetically damped types, providing 0 to 300 cps range.
Record material	70 mm wide photographic record paper or film.
Record magazine	Daylight loading, 100 foot capacity.
Record speeds	6 steps from ¾" to 24" per second.
Time indication	½ inch lines photographed along edge of record at 1/10th and 1/100th second intervals.
Record identification	5 digit number automatically advanced and photographed at start of each run.
Controls	Recording Switch, Galvanometer Illuminator Rheostat, Power On-Off Switch.
Viewing screen	Calibrated ground glass screen for initial spot setting and observation of galvanometer traces.
Connectors	Individual locking-type connector for each galvanometer input.
Power requirement	115 volt, 60 cycle ac, 90 watts maximum.
Weight	24 pounds.
Dimensions	Width 5½"—Height 8½"—Length 14⅝".

Consolidated Engineering CORPORATION

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

300 North Sierra Madre Villa, Pasadena 15, California — *Sales and Service through* **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Atlanta, Chicago, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*

For more information circle **19** on inquiry card.

CUSTOM BUILT

Electrical Enclosures

by KIRK AND BLUM

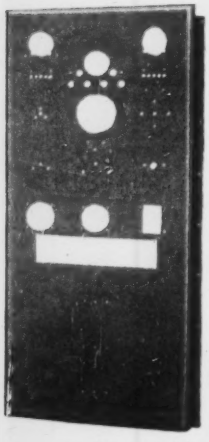
KIRK & BLUM can produce any type of metal enclosure . . . quickly and economically.

Facilities for fabrication of sheet steel, plate, light structurals, stainless, aluminum, monel and other alloys.

Whatever your needs, send prints to Kirk & Blum for prompt quotation. For literature on electrical enclosure fabrication facilities and experience, write to: The Kirk & Blum Mfg. Co., 3111 Forrer Street, Cincinnati 9, Ohio.

CONTRACT MANUFACTURING FACILITIES FOR

- Control Desks
- Instrument Panels
- Boiler, Turbine, Generator Panels
- Power Distribution, Control Panels
- Switch Gear Housings
- Cubicles • Machine Bases
- Weatherproof Housings
- Breechings • Air Ducts
- Transformer Enclosures
- Stacks • Casings • Hoppers



KIRK AND BLUM

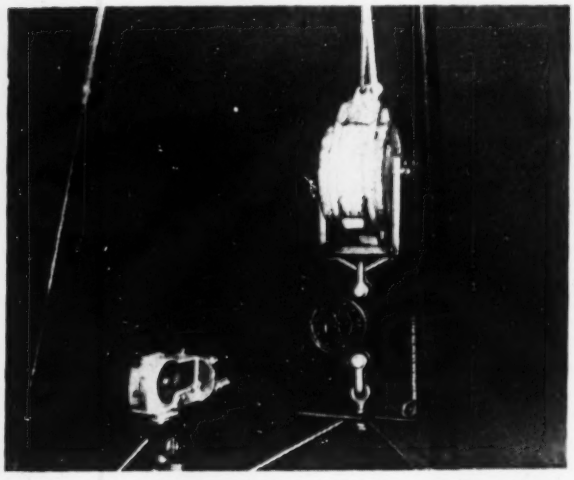
METAL FABRICATION

For more information circle 20 on inquiry card.

in the calibration of the 15-, 30-, and 45-degree angle blocks of the master sets which industry uses to control the shape —and hence the interchangeability and proper functioning —of mechanical parts produced by mass production methods. However, the principle of the device is expected to find considerable application in the routine angular measurement work of the optical and mechanical industries. Angles in multiples of 15 deg. can be obtained from the polygon by sighting an autocollimator on the two faces which define the angle and then determining the angular difference between the two settings.

Belt Test

DENVER, COLO.—A means of testing safety belts not only for their breaking point but for the amount of kinetic energy absorbed, has been developed by the Rose Manufacturing Company of Denver, manufacturers of safety belts. This test involves the use of a Dillon dynamometer.



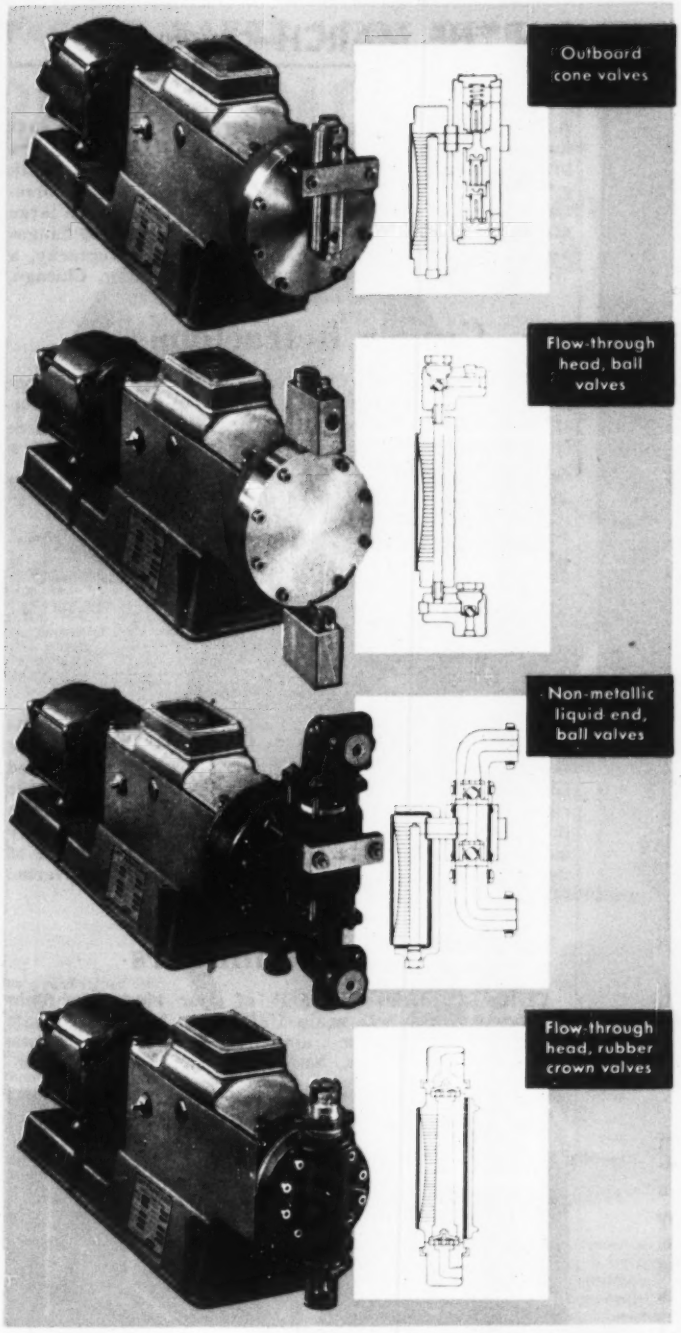
A hoist suspended from a tripod exerts a pull against a safety belt positioned around a drum. The drum in turn is bolted in series with the dynamometer, the entire assembly being anchored to the base of the tripod. The drum is used to simulate the pressure caused by a man's body against the safety belt. A steel tape is fastened at the anchor point, and is attached to the top of the tripod by a wire. The slow-motion camera at lower left of the picture records both the poundage of the dynamometer dial as tension is increased, and the extension of the tape as pull is exerted and the safety belt stretches.

Variable Inductors

STAMFORD, CONN.—The "Vidigage" ultrasonic thickness tester of Branson Instruments, Inc., Stamford, Conn., uses "Vari-L" variable inductor to control the frequency deviation from 5 to 105 percent. A small electric current controls the inductance of the high-Q toroidal "Vari-L" inductor.

"Hot Tapping"

TULSA, OKLA.—"Hot tapping" means cutting into a pipe while it is in service. The most common reason for making such a cut is to add a branch or meter-tap connection. An improved tapping procedure, developed by T. D. William-


Outboard cone valves
Flow-through head, ball valves
Non-metallic liquid end, ball valves
Flow-through head, rubber crown valves

4 VALVE CONSTRUCTIONS

TO CHOOSE FROM IN

Lapp PULSAFEEDER

PISTON-DIAPHRAGM CONTROLLED-VOLUME CHEMICAL PUMPS

No one valve design or construction is adequate to handle all types of materials which must be pumped in controlled volume. Experience indicates that flow characteristics of fluids are greatly influenced by viscosity, specific gravity, lubricity and temperature; solids in suspension require a special design, whereas low-viscosity, non-lubricating liquids present a wholly different valving problem. Lapp offers the Pulsafeeder in a variety of liquid-end designs, materials of construction, and valve assemblies—four of which are shown here. For your "special problem" in proportioned pumping of liquids, ask us for an engineering recommendation on the Pulsafeeder assembly specifically suited.

WRITE FOR BULLETIN 300 *with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 125 Wilson St., Le Roy, N. Y.*

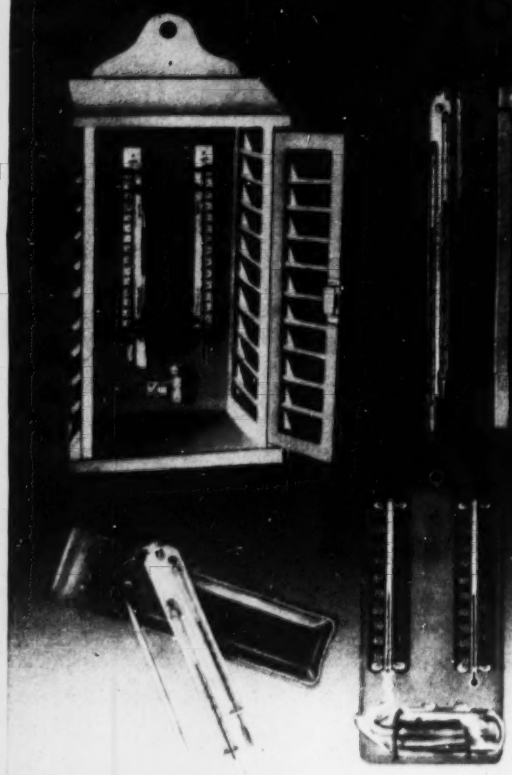
POSITIVE DISPLACEMENT...AND NO STUFFING BOX!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

Lapp

For more information circle 21 on inquiry card.

Changeable as the Weather



PSYCHROMETERS

Nothing's as changeable as the weather unless it's the response of a reading indicated by a Moeller Psychrometer. They are capable of indicating such changes as they occur and are designed for efficient service. For over 80 years in rain, sleet, snow and hail, Moeller Psychrometers have proven accurate and reliable.

Send for catalogs and literature on
INDUSTRIAL, LABORATORY
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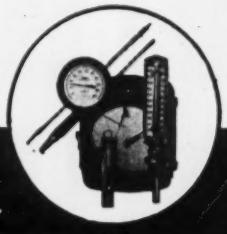


MOELLER
INSTRUMENT COMPANY
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

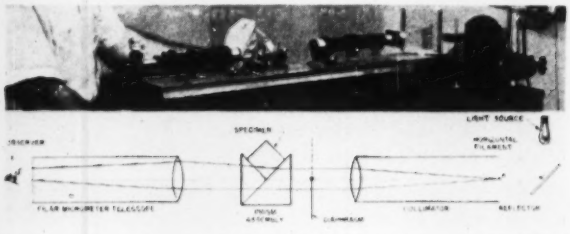
For more information circle **22** on inquiry card.

ON THE MARCH—CONTINUED

son, Inc., Tulsa, entails the use of (1) a special plug that makes it unnecessary to leave a gate valve attached to the branch connection, and (2) a special fitting, fabricated with a "Tube-Turn" barrel-shaped tee, which gives the reinforcement desirable when dealing with high pressures and large diameter pipe and taps. "The "Tube-Turn" tees and flanges are manufactured by Tube Turns, Louisville, Kentucky, a division of the National Cylinder Gas Company, Chicago.

Grauer Refractometer

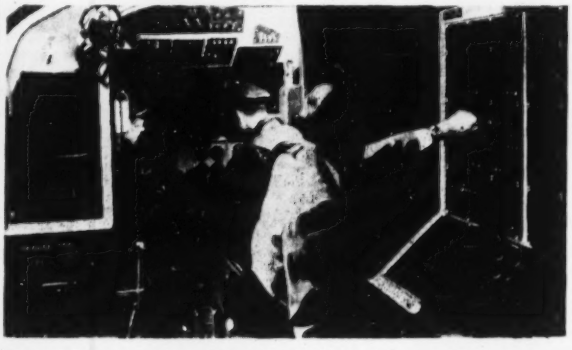
WASHINGTON, D. C.—With this improved refractometer, recently developed by Oscar H. Grauer at the National Bureau of Standards, the index of refraction of a piece of glass can be measured with high accuracy in only a few



minutes. The glass sample, cut with a 90-degree angle, fits into a prism assembly (center). Looking into the telescope (left) the observer sees a double image of an illuminated filament. (Filament, light source, and collimater are at the right.) The separation between the two images varies with the index of refraction of the glass sample, and is accurately measured by means of a filar micrometer that is part of the telescope; the micrometer readings are readily converted to index of refraction.

Flight Simulators

CHICAGO, ILL.—The first of four electronic flight simulators, which will equip United Air Lines to conduct the most advanced pilot training program in the domestic air transport industry, has been completed by Curtiss-



Wright Corporation. The simulators will cost United more than $3,000,000. The one just completed electronically duplicates the flight characteristics of a Mainliner Convair. It will be followed by another Convair and two of the DC-6 type.

Electronic servomechanisms translate the operation of the various flight controls into instrument reading, such as air speed and rate of climb. Illusion of flight is sharpened by aircraft sounds, electronically synchronized with operation of the simulator. These include take-off engine roar, propeller tip noise and, on landing, the screech of tires.

FASTER, SAFER, LESS EXPENSIVE FLIGHT TESTING

BENDIX-PACIFIC TELEMETERING SYSTEMS

RADAR

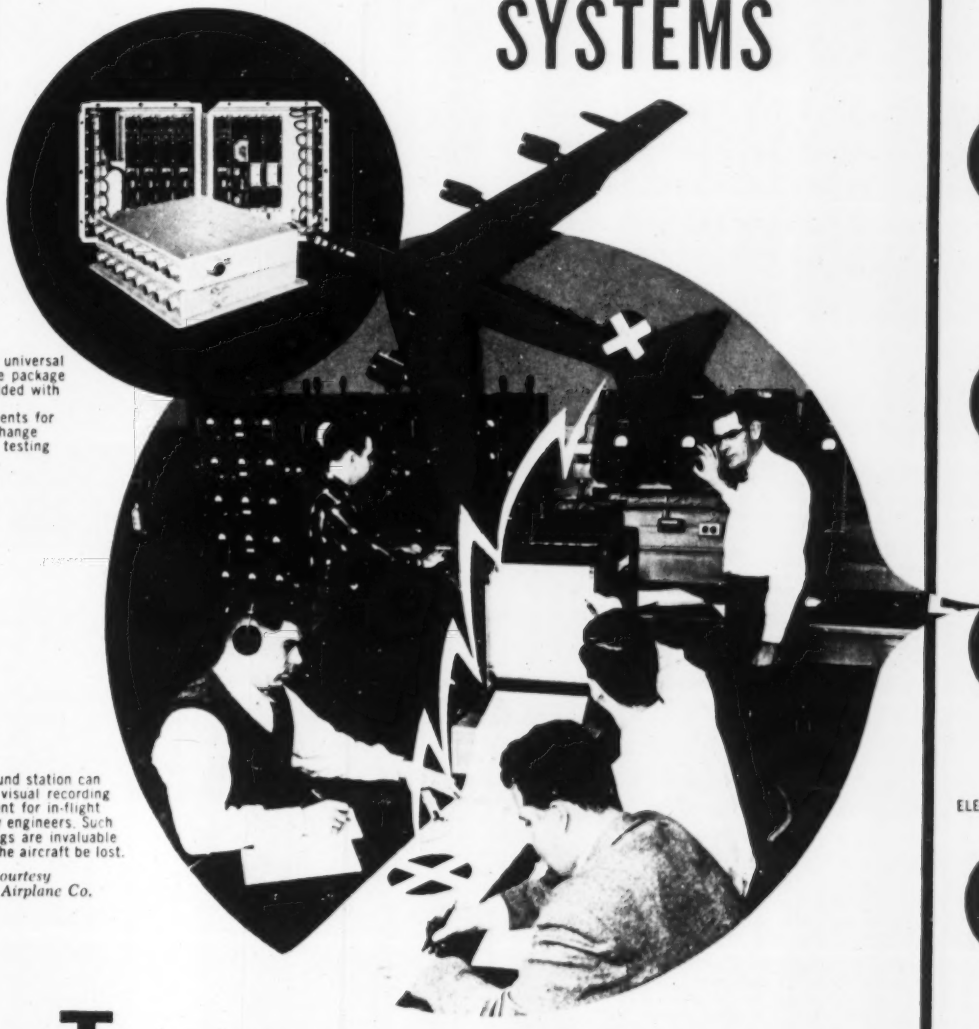
SONAR

HYDRAULICS

TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS



Typical universal airborne package is provided with plug-in components for quick change over of testing factors.

The ground station can include visual recording equipment for in-flight study by engineers. Such recordings are invaluable should the aircraft be lost.

Photo courtesy Boeing Airplane Co.

The flexibility and effectiveness of Bendix-Pacific Telemetering Systems are materially speeding up flight test programs for several air frame companies, and cutting costs at the same time.

Standardized Systems are available which provide for compact, lightweight airborne equipment and stable ground recording stations. The systems will measure any kind of information that can be recorded by older methods—and with an accuracy that can be depended upon.

The effectiveness of Bendix-Pacific telemetering equipment is being demonstrated in the wide range and multiplicity of information transmitted simultaneously. Numerous flutter tests, for example, can be observed and flight conditions varied by radio communication while a single flight is in progress. The crew is free to concentrate on flying the airplane. The system also offers an important safety factor by warning of any dangerous conditions.

BENDIX-PACIFIC TELEMETERING SYSTEMS Accurately Measure
Vibration • Temperature • Pressure • Acceleration • Strain • Motion

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

BENDIX PACIFIC

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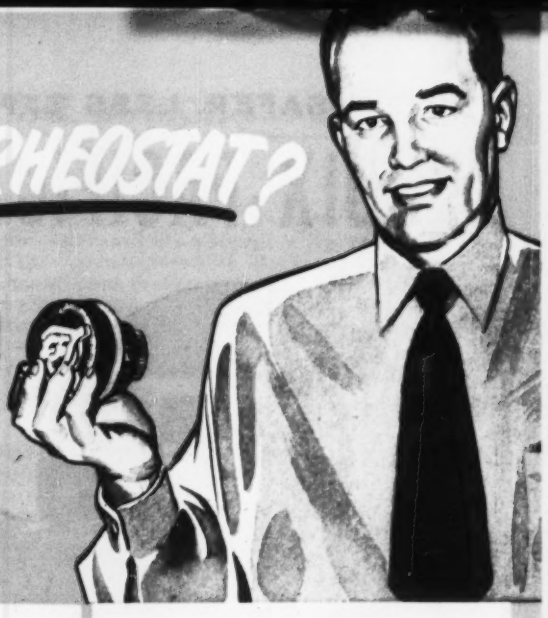
23

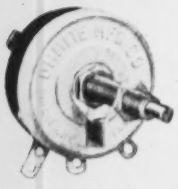
What Special Feature do you need in a RHEOSTAT?



OHMITE CAN SUPPLY IT!

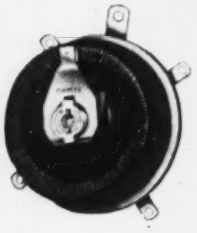
In addition to standard rheostats, Ohmite offers rheostats with a wide variety of *special features.* All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel.

BUSHINGS FOR SPECIAL PANEL THICKNESS



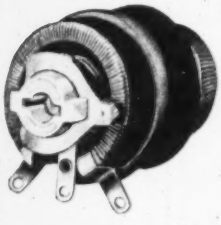
Extra-long bushings and shafts allow mounting on panels up to 2 inches in thickness. Seven bushing lengths are available, from ¼ to 2⅛ inches.

360° WINDING



Two small models available with continuous circular core and endless winding. Unlimited rotation of shaft and contact arm. Taps supplied at any desired angle on windings.

DEAD LUG OFF POSITION

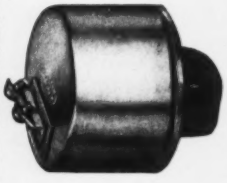


Opens the circuit at the high or low resistance position as the contact passes on to the lug, which is disconnected from the winding. Recommended for light duty.

SCREW DRIVER SLOT SHAFT

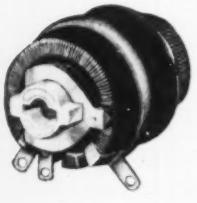
Where infrequent adjustments are needed, shaft ends can be slotted for operation with a screwdriver. Tampering with the shaft setting is thus minimized.

SEALED, ENCLOSED CAGES



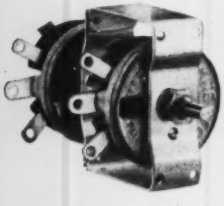
Compact, corrosion-resisting metal enclosure, permanently sealed by a double seam, protects the unit completely. Available with rheostat Models H and J.

SNAP-ACTION OFF POSITION



Opens the rheostat circuit at the high or low resistance position. The circuit is opened as the brush snaps into an insulated notch next to the lug, providing indexing.

TANDEM ASSEMBLIES

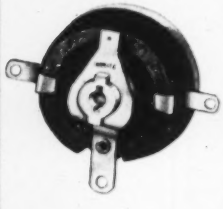


Ohmite rheostats can be mounted two or more in tandem, for simultaneous operation of several circuits. Universal joints provide smooth, positive mechanical action.

TOGGLE SWITCH

Toggle switch is operated with a positive snap by the movement of the contact arm. Opens the rheostat circuit or switches an independent circuit. Available for all models.

LESS THAN STANDARD ROTATION



Rheostats can be supplied with winding space and angle of rotation less than standard. Rheostats can also be supplied with fixed or adjustable stops.

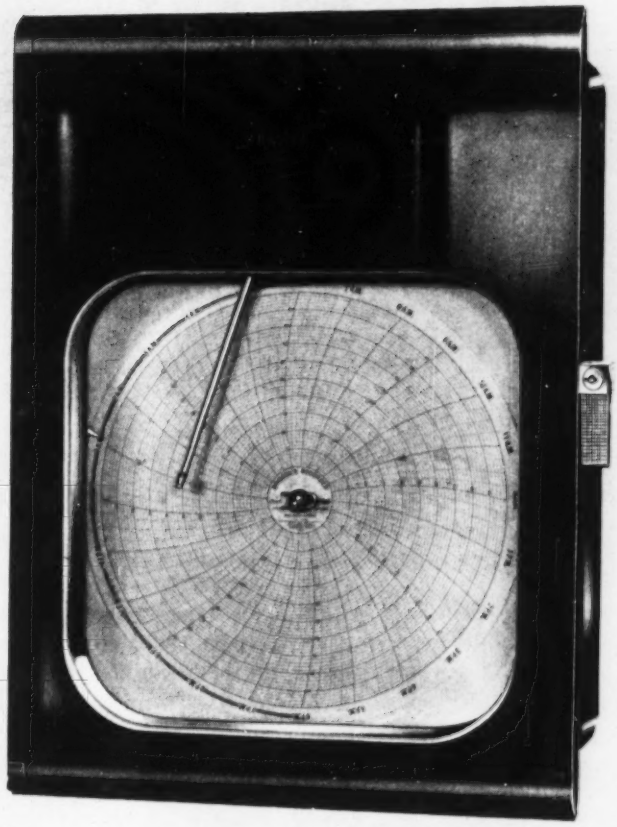
OHMITE MANUFACTURING COMPANY
3615 Howard Street, Skokie, Illinois (Suburb of Chicago)

WRITE on Company Letterhead for Catalog and Engineering Manual No. 40.

Be Right with

OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES



EASY-TO-USE BRISTOL RECORDING GAUGES come in pressure ranges from 0 - 0.2 inch of water to 0 - 10,000 psi. Vacuum gauges are available in various ranges from 0 - 30 inches of mercury and absolute pressure gauges in ranges as low as 0 - 6 mm mercury absolute.

Why are more Bristol recording gauges in use than all others put together?

• That's easy — accuracy and dependability are the reasons.

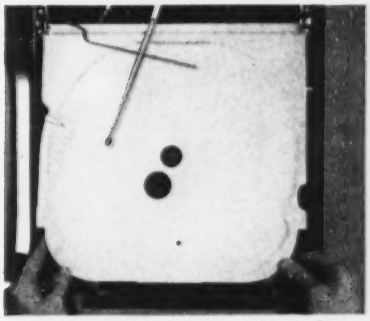
For accuracy, Bristol's measuring elements are unsurpassed. They are the product of 65 years of research and development. Bristol engineers are constantly engaged in developing pressure and vacuum measuring elements of higher accuracy, greater sensitivity, and increased stability.

As for dependability, many Bristol gauges have been in constant operation for more than 40 years — without special attention of any kind!

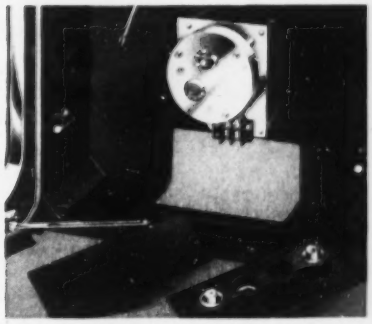
You can get the Series 500 gauge in models designed for recording, controlling and telemetering. Write today for free 32-page Bulletin G621. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

Many ranges carried in stock for immediate delivery

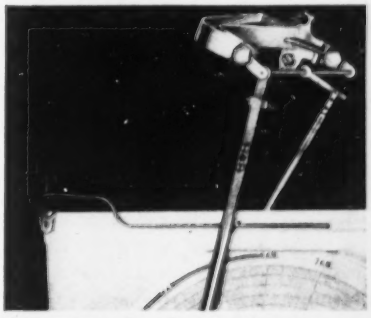
LOOK AT THESE "HUMAN-ENGINEERED" FEATURES!



SNAP-ON TYPE CHART PLATE — No tools are needed to remove chart plate. Spring, finger release permits quick access to the space beneath the chart. Plate is easily replaced.



UNIVERSAL CONNECTION BLOCK — Mounting block for instrument connections easily changed from bottom to back of case or vice versa; measuring system can be removed or replaced.



PEN LIFTER — Simple, non-obscuring pen lifter, mounted independently of the chart plate, raises pen from the chart, provides complete freedom for working on instrument with chart plate removed.

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle 25 on inquiry card.

Circle **24** on inquiry card.

You can get complete FM-AM coverage

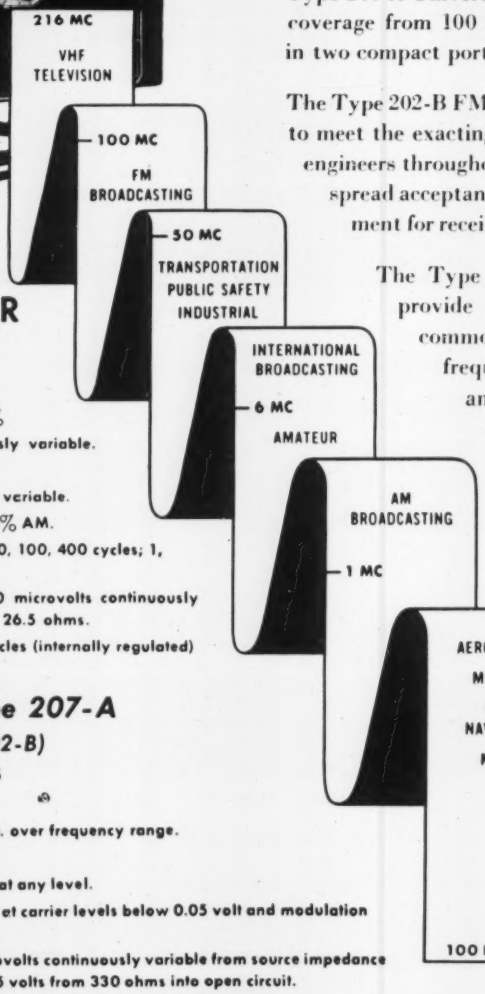
100 KC to 216 MC

PRICE: $975.00
F. O. B. Boonton, N. J.

The Type 202-B FM-AM Signal Generator and the Type 207-A Univerter provide complete FM-AM signal coverage from 100 KC continuously through 216 MC in two compact portable units.

The Type 202-B FM-AM Signal Generator was designed to meet the exacting requirements set forth by leading engineers throughout the country and has found widespread acceptance as the essential laboratory instrument for receiver development and research work.

The Type 207-A Univerter was designed to provide additional frequency coverage of commonly used intermediate and radio frequencies and enables the modulation and attenuation calibration features of the 202-B to be utilized at these lower frequencies.



FM-AM SIGNAL GENERATOR *Type 202-B*

SPECIFICATIONS

FREQUENCY RANGE: 54—216 MC ± 0.5%
FM MODULATION: 0—240 KC continuously variable.
FM DISTORTION: Less than 2% at 75 KC.
AM MODULATION: 0—50% continuously variable.
AM DISTORTION: Approximately 5% at 50% AM.
INTERNAL MODULATING FREQUENCIES: 50, 100, 400 cycles; 1, 5, 7.5, 10, 15 KC.
R. F. OUTPUT VOLTAGE: 0.1 to 200,000 microvolts continuously variable from source impedance of 26.5 ohms.
POWER SUPPLY: 105—125 volts, 50/60 cycles (internally regulated)

UNIVERTER *Type 207-A*

(When used with 202-B)

SPECIFICATIONS

FREQUENCY RANGE: 100 KC—55 MC.
FREQUENCY RESPONSE: Flat within ± 1 db. over frequency range.
FM-AM MODULATION: See 202-B.
FM DISTORTION: No appreciable distortion at any level.
AM DISTORTION: No appreciable distortion at carrier levels below 0.05 volt and modulation of 50%.
RF OUTPUT VOLTAGE: 0.1 to 100,000 microvolts continuously variable from source impedance of 26.5 ohms; also approximately 1.5 volts from 330 ohms into open circuit.
POWER SUPPLY: 90—130 volts, 60 cycles (internally regulated).

PRICE: $345.00
F. O. B. Boonton, N. J.

Write for CATALOG "J"

BOONTON RADIO Corporation
BOONTON · N·J · U·S·A

For more information circle **26** on inquiry card.

THE VALVE THAT CONQUERS *FLASHING* CONDENSATES

Better Control, with Lower Initial and Maintenance Costs

Use Annin valves for better control of steam and condensates to 2500 PSI and 900° F *without* use of hard-to-maintain special assemblies. Flanged seat ring eliminates seal welding. Body construction eliminates liners and reduces down stream piping erosion. Available with manual, cylinder or Domotor automatic operators. Single seat provides bubble-tight shut-off. For better control, longer life, and lower maintenance use ANNIN CONTROL VALVES.

THE ANNIN COMPANY

6570 E. Telegraph Road, Los Angeles 22, California

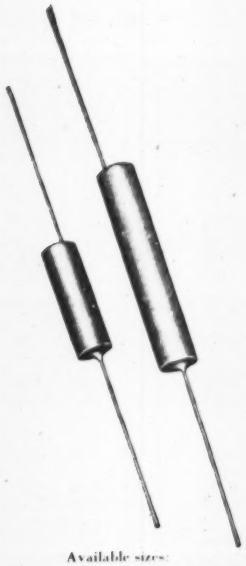
ANNIN
Control
VALVES

WRITE TODAY FOR ILLUSTRATED CATALOG 1500 B

You'll profit by learning more about the superior features and better performance of Annin Control Valves.

For more information circle **27** on inquiry card.

QUALITY CAN COST LESS



Available sizes:
1 watt..... 1 to 1000 ohms
$\frac{5}{16}$" dia. x 1" long
7 watt..... 1 to 5000 ohms
$\frac{5}{16}$" dia. x $1\frac{3}{4}$" long
Standard Tolerance..... 10%

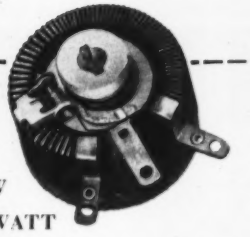
. . . And MALLORY Ceramic Resistors Prove It!

Wherever you need fixed resistors in television and other electronic circuits, you can get an ideal combination of quality and economy in Mallory Ceramic Resistors. They're low in cost—and their axial lead construction cuts production expense by eliminating mounting brackets, permitting point-to-point wiring and saving under-chassis space.

These features assure top quality performance:

- ***Accurate resistance up to rated wattage through the use of exclusive Mallory Yard-Ohm wire.***
- ***Long life: Fiberglas core contains no organic materials; high grade non-corrosive inorganic cement, injected under pressure to give high heat dissipation, holds resistance element securely. Resistors are built to take 100% overloads.***
- ***Moisture protection: Resistor ends are sealed by special heat and moisture resistant compound.***
- ***Rugged construction: tinned leads are securely clinched to prevent opens, high resistance and pull-outs. Non-porous steatite tubes protect against mechanical and thermal shock.***

For complete facts, write for the new catalog on fixed wire-wound resistors and carbon and wire-wound controls.



NEW 25-WATT RHEOSTAT

A line of wire-wound rheostats, with ranges from 1 to 2500 ohms, is now available. A patented hinged-spring contact arm provides smooth rotation and assures correct, constant pressure against the winding. Write for information.

Expect more . . . Get more from **MALLORY**

Parts distributors in all major cities stock Mallory standard components for your convenience

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

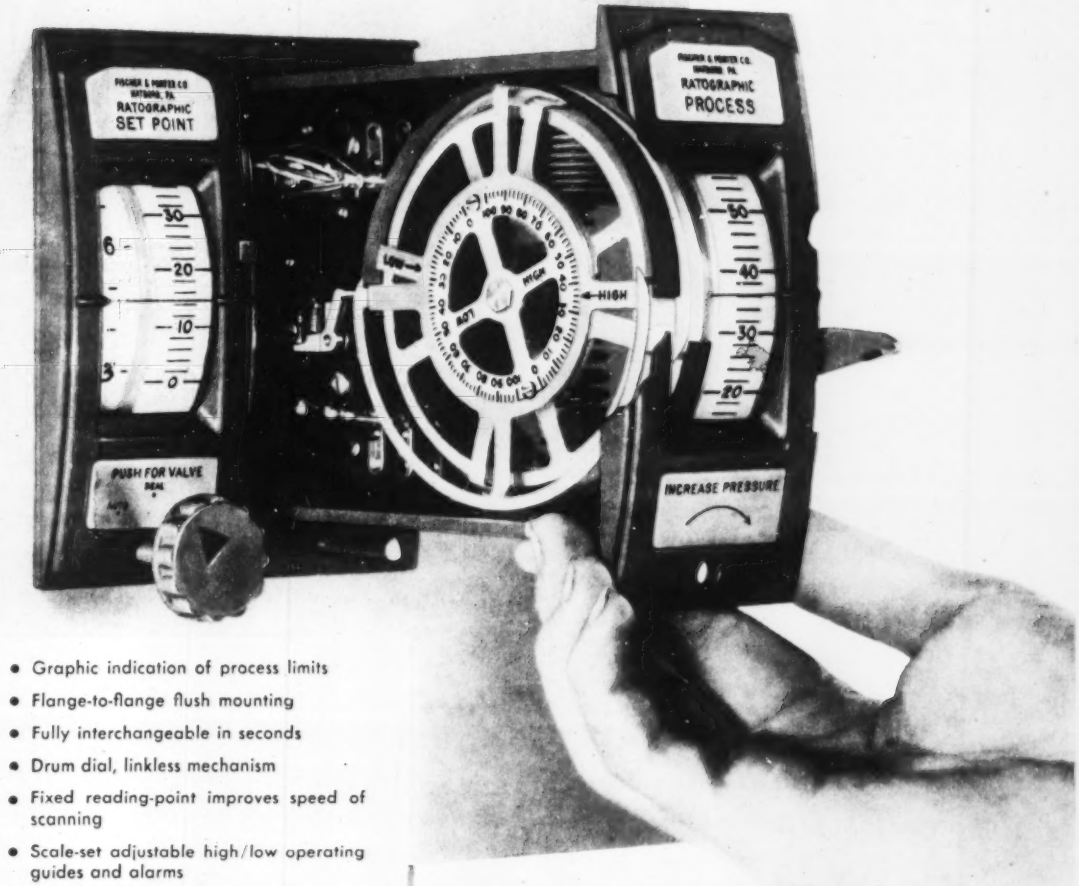
Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

For more information circle **28** on inquiry card

Circle **29** on inquiry card →

NEW

Ratographic* miniature indicators



- Graphic indication of process limits
- Flange-to-flange flush mounting
- Fully interchangeable in seconds
- Drum dial, linkless mechanism
- Fixed reading-point improves speed of scanning
- Scale-set adjustable high/low operating guides and alarms
- Plug-in unit easily removed with finger jack for check or change

Completely described and illustrated in Catalog 55-10. Write for it today.

Fits panel space only 2⅜" x 5⅜"
yet with 5¾" long, readable
scale in keeping with ½% accuracy.
Unique, new "graphic guides" mark high/low operating range, are adjustably mounted on scale drum and carry switch trippers to actuate alarms or take emergency action. Rotating drum dial and fixed reading point permit large, easily read figures and open, uniform scale. Building block construction of Ratographic indicators permits field addition of alarms and guides to the basic precision pneumatic indicator. Illustrated are two indicators which form a control selector station accessory for remotely mounted controllers.

complete process instrumentation

FISCHER & PORTER CO.

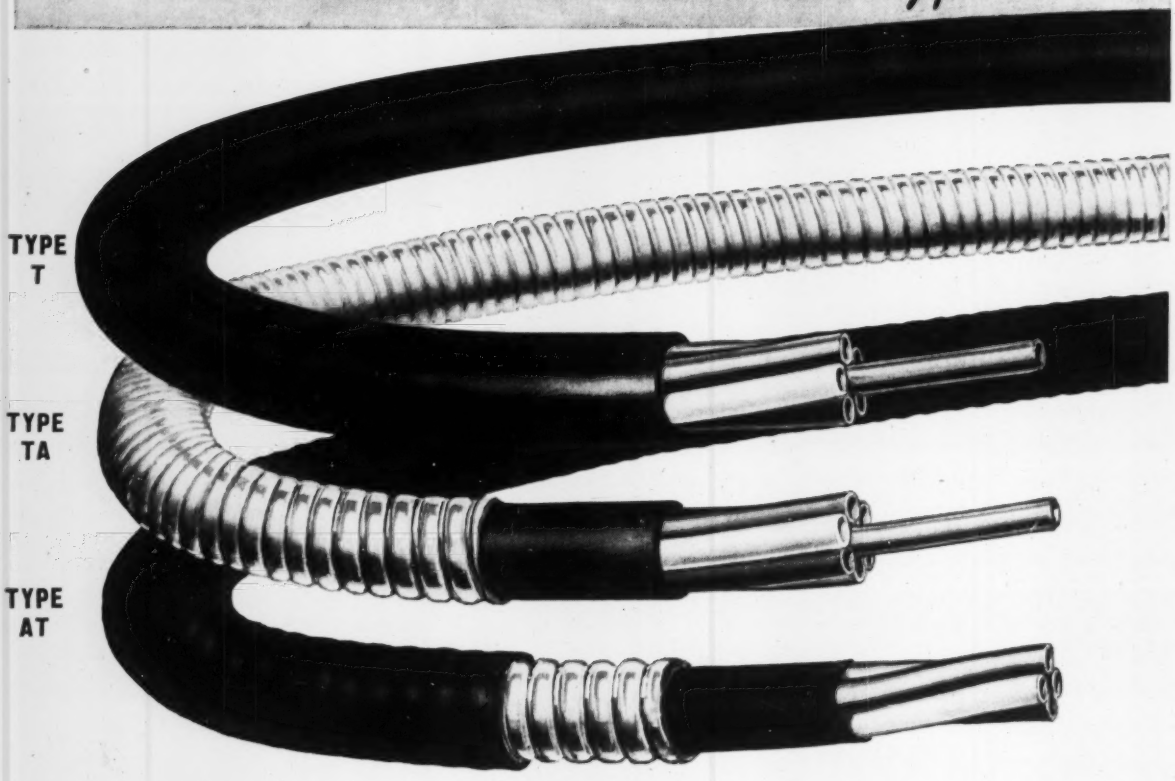
130 County Line Road, Hatboro, Penn.

*T.M., F&P Co.

Company owned sales and service branches strategically located throughout the world.

CRESCENT ARMORED MULTITUBE

In 3 Corrosion Resistant Types



For Pneumatic and Hydraulic Instrument Controls

TYPE T—In damp or corrosive locations where a moderate degree of mechanical protection to the tube is required, as in troughs or attached to building surfaces or supporting means, the construction shown in top view is recommended. It employs a tough corrosion-resistant thermoplastic sheath, resistant to water, acids, alkalies, oils, most chemicals, and is flame-retardant.

TYPE TA—Where maximum mechanical protection is desired during or after installation, such as direct burial in concrete and pulling into conduit, an interlocked galvanized steel armor over the thermoplastic sheath, as shown in middle construction above, is recommended.

TYPE AT—For maximum protection against corrosion and mechanical injury to the tubing, the thermoplastic sheath is applied over the flexible steel armor as shown in the bottom construction illustrated above.

These forms also provide the other advantages possessed by CRESCENT ARMORED MULTITUBE which include permanence, lower over-all cost and ease of installation.

CRESCENT ARMORED MULTITUBE consists of long length tubes twisted together to permit bending without distortion. In each layer one tube is a bright blue color, affording a fast means of identification from both ends.

Available in long runs of copper, aluminum or polyethylene tubing in size $\frac{1}{4}$" O.D. This product is licensed under U.S. Patent 2,578,280.

SEND FOR BULLETIN GIVING COMPLETE INFORMATION AND ENGINEERING DATA.

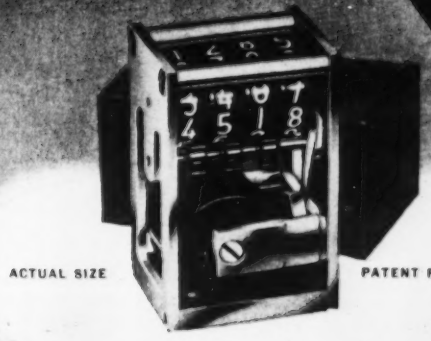
CRESCENT INSULATED WIRE & CABLE CO.
TRENTON, NEW JERSEY

For more information circle **30** on inquiry card.

HIGH SPEED

Miniature Electromagnetic

COUNTER



ACTUAL SIZE — PATENT PENDING

40 counts per second
— higher rates with suitable circuit design

Miniaturized — only 27/32 x 31/32 x 1-7/32 inches

Lightweight — 1.2 ounces (less cover); 1.5 ounces (with cover)

Shock-resistant dynamically balanced armature.

Reads 0 - 9999, 4 dials, non-reset.

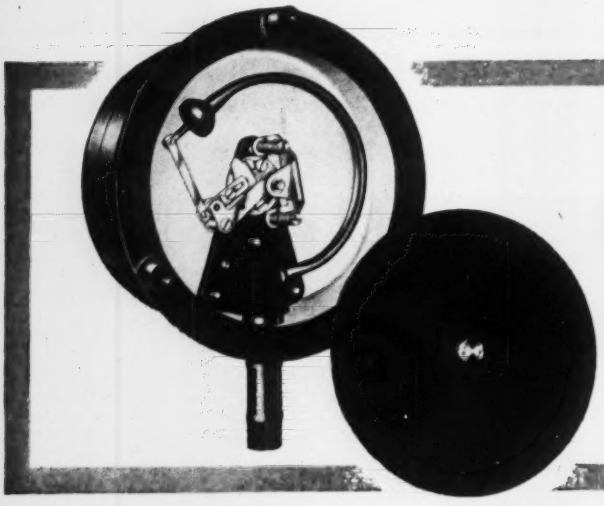
Write for data sheet giving performance and dimensions of the Unimax C-100 Counter.

UNIMAX

Switch Division of The W. L. Maxson Corporation

460 WEST 34th STREET, NEW YORK 1, NEW YORK

For more information circle **31** on inquiry card.



EASY TO SERVICE...

a plus value of ASHCROFT *Maxisafe* DURAGAUGES

Turn the knob on the back of the *Maxisafe* and the plate comes off, fully exposing the entire mechanism for fast and easy inspection, recalibration or adjustment. This time and money-saving feature is highly favored wherever Ashcroft *Maxisafe* Duragauges are in service.

This Duragauge was named *Maxisafe* because it has an integrally-cast wall to separate the dial from the movement and Bourdon Tube assembly — a solid wall of safety that protects the viewer if the tube ever ruptures. Covering the back of the case is a double spring mounted safety release plate — a Teflon-coated plate tightly fitted on a rubber gasket and held in place by a knurled knob. Less than 0.5 psi pressure created by a ruptured tube forces this cover open — vents the discharge safely to the rear.

The Maxisafe is available in 4½", 6" and 8½" dial sizes. You can have a choice of standard Ashcroft Duragauge pressure ranges, case designs (except Types 1179 and 1279), and mountings. Get the utmost in sustained accuracy, durability, protection and convenient servicing. Specify Ashcroft *Maxisafe* Duragauges.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has complete facts about Ashcroft Gauges of all types. You can depend on his knowledge and experience to help you satisfy every requirement of the application. He maintains local stocks to serve you promptly and economically.

1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

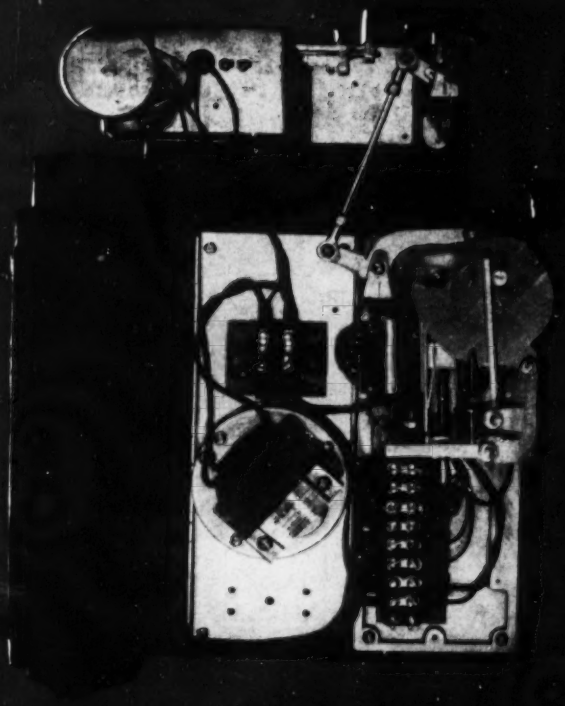
MAXWELL MANNING MM & MOORE TRADE MARK

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle **32** on inquiry card.

a new electronic flow meter!



continuous integration —no creep at zero

unaffected by normal voltage, frequency and temperature changes

electronic operation provides high speed and greater accuracy

3 to 1 range calibration at recorder

HAYS Electronic Flow Meter

Since the circuit is of the electronic null-balance type, it is unaffected by normal voltage and frequency variations. Also, neither temperature variations nor reasonable length of transmission lines affect the calibration of the instrument.

The *pen-drive motor* is built for reversing duty. Normal variations in voltage and frequency have no noticeable effect on its operation.

The *integrator* is continuous in operation and simple in mechanical construction. A micrometer zero adjustment for calibration is easily accessible.

Indicators can be calibrated to read directly in rate-of-flow or other factors as desired.

Write today for full information on the Hays Electronic Flow Meter Bulletin 52-1074-222.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Venturi-flow Meters and Venturi
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 8, INDIANA

For more information circle 33 on inquiry card.

CUT
INSTALLATION COSTS
36 to 71%
with
IMPERIAL
Hi-Duty®
TUBE FITTINGS

ANYONE can assemble the Imperial Hi-Duty Fitting in record time. Actually there is a 36% saving in installation time as compared to regular compression fittings . . . a 71% saving as compared to flare fittings. See table below.

Why Does the IMPERIAL Hi-Duty Fitting cut installation costs? Fitting is furnished with one-piece nut and sleeve, and sleeve shears off and becomes attached to tube in assembly. To make a joint you simply push tube into fitting and tighten nut. No need to disassemble to get sleeve in proper alignment — or inspect to be sure it's there. No chance of sleeve being in backward — or of dropping a loose sleeve. No flaring required.

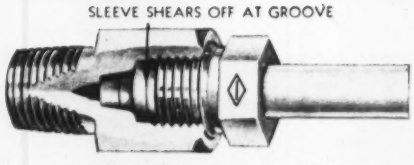
MAKES STRONGER JOINTS

Hi-Duty Fitting is so designed that it provides a Double Seal for safety. This, plus its perfect sleeve alignment and vibration damping action, assures stronger joints that withstand higher pressures and more vibration. Tests show Hi-Duty Fittings will stand over 5 times as much vibration as joints made with ordinary compression or flare fittings.

Furnished in Brass, Aluminum, Steel and Stainless Steel

For Tubing ⅛" to 1" O.D.

Ask for Bulletin No. 3002



Section Through Hi-Duty Fitting After Assembly

The sleeve on Hi-Duty Fittings shears off during assembly and becomes permanently attached to tube. Fitting will make repeated tight reconnections.

Average Time Required to Assemble Fittings

Type of Fitting	Average Time Each Joint	Joints per Hour
HI-DUTY	13.2 sec.	274
Regular Compression	20.8 sec.	173
Flare	45 sec.	80

The ORIGINAL Fitting with perfect sleeve alignment. Proved by years of use.

See Your Industrial Supply House

THE IMPERIAL BRASS MANUFACTURING COMPANY
1204 W. Harrison St., Chicago 7, Ill.
In Canada: 334 Lauder Ave., Toronto, Ontario

IMPERIAL

Pioneers in Tube Fittings and Tube Working Tools

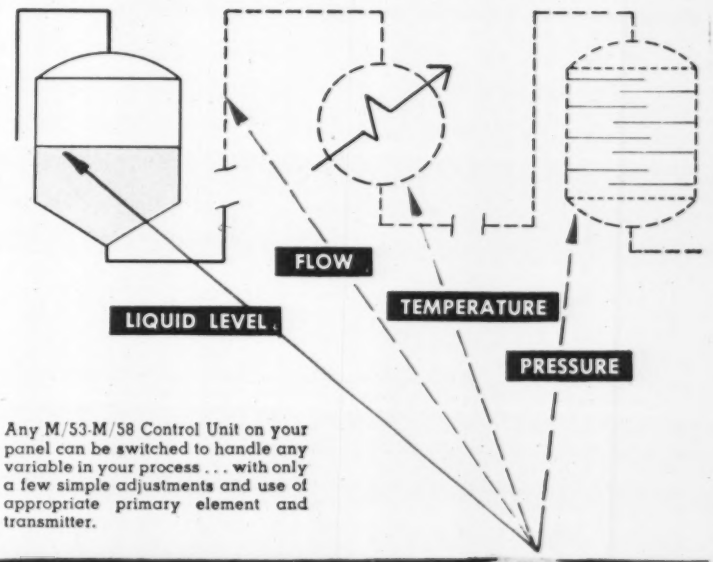
For more information circle 34 on inquiry card.

No obsolescence for this controller when process requirements change!

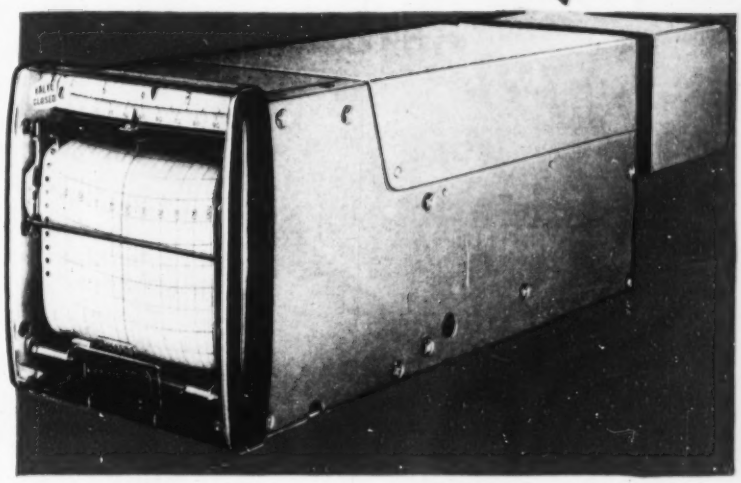
That's right! The Foxboro M/53-M/58 Recorder-Controller is a "universal" instrument, equally adaptable to any process measurement — whether flow, temperature, pressure, liquid level, or other.

All it takes is connection to the proper measurement transmitter having a 3-15 psi pneumatic signal . . . and making the appropriate controller settings. Changes such as adding derivative to reset or proportional control can be made *on the job* without special tools or realignments. You save needless duplication in capital investment . . . save time and trouble in making process revamps . . . and get the unsurpassed performance of M/58 control on every application!

Whether you favor graphic, console, or conventional mounting, you can cut instrument overhead at every stage, step-up efficiency in every operation, with the Foxboro M/53-M/58 Recorder-Controller. Write for complete information. **The Foxboro Company, 465 Neponset Ave., Foxboro, Mass., U.S.A.**



Any M/53-M/58 Control Unit on your panel can be switched to handle any variable in your process . . . with only a few simple adjustments and use of appropriate primary element and transmitter.



OTHER BASIC ECONOMIES

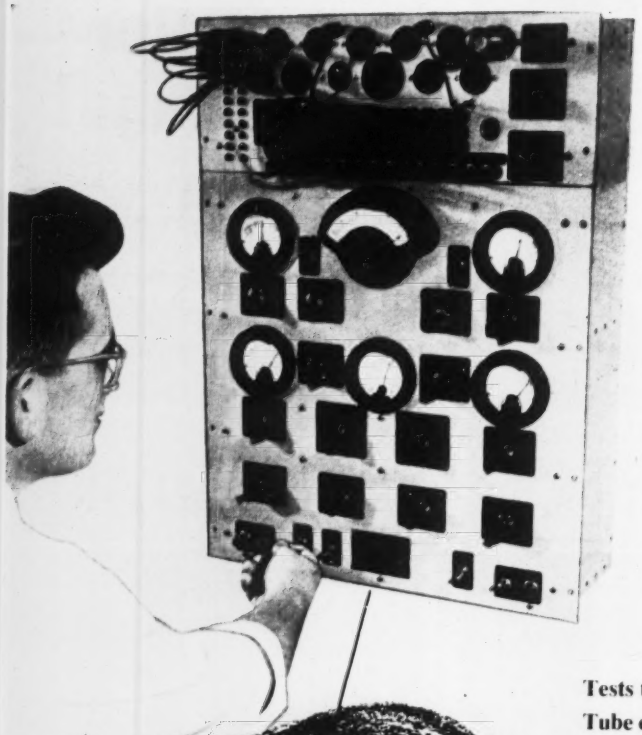
- **Simplified Ordering**
  —complex specification sheets are eliminated.
- **Reduced Stock Inventory**
  —only one type recorder-controller for all control jobs.
- **Reduced Maintenance**
  —fewest parts, rugged design, no diaphragms, highest quality throughout.

FOXBORO
REG. U.S. PAT. OFF.

Consotrol Process Control

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

For more information circle **35** on inquiry card.



WESTON

(686 Type 10A)

true mutual conductance

ELECTRONIC TUBE ANALYZER

(over-all Gm accuracy 3% or better)

LABORATORY FOR ELECTRONIC TUBES

Tests tubes under actual circuit operating potentials.

Tube characteristic operating curves can be plotted for comparison with manufacturer's specifications.

Transconductance can be measured directly without need for null adjustments or correction factors.

Voltage Ratio method of measuring transconductance meets the IRE Standard 50 IRE 7.S2 paragraph 7.2.2.4.

Completely self-contained with all necessary power supplies, meters and switching for performing short tests, static characteristic measurements and grid to plate transconductance measurements.

A well filtered d-c power source is supplied, making it possible to test tubes with d-c potentials which can be accurately adjusted to correspond to actual circuit voltage operating conditions.

Precision meter shunts and **multipliers** are wire wound to 0.5 per cent accuracy.

Special circuitry makes meter loading effects negligible.

Regulated grid bias supply keeps this most critical voltage constant. Plate and screen supplies do not affect grid bias setting.

Wide range of measurement of transconductance provides good readings on all tubes from small subminiature types to large power control types. The true transconductance is obtained on all triodes and pentodes, including low mu control tubes having plate resistance as low as 250 ohms.

Transconductance ranges are available in the following combinations of range and grid signal voltages:

Grid Signal	1.0	0.5	0.2	0.1	Volts
Gm x 1	300	600	1500	3000	Micromhos
Gm x 10	3000	6000	15000	30000	Micromhos

The *Gm x 1* range is especially useful in the measurement of subminiature tubes having low transconductance.

Reliability, Dependability and **Accuracy** assured by sound engineering, skilled manufacture and high quality components.

Descriptive literature on Model 686 gladly sent on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J.

WESTON *Instruments*

7049

For more information circle **36** on inquiry card.

MINIATURE IN SIZE...

GIANT in performance

The dial of this Gotham "Miniature" Mercury Dial Thermometer is only 2½" in diameter, but everything else about it is large-scale. Built for those applications where panel and mounting space are at a premium, it gives you all the accuracy, sensitivity and durability you could ask for.

The entire thermal system is stainless steel with a bulb only half the size of a standard bulb. This small bulb length now enables you to obtain the ruggedness and reliability of mercury actuation in places where only non-mercury actuated thermometers could be used before.

A linear dial—with uniform graduations over a 270° arc—permits precise temperature readings at a glance.

If your application requires a remote reading, quality dial thermometer with hairline sensitivity, constant accuracy and dependability mounted in a small space, the Gotham "Miniature" is your answer. It's designed to give top performance under the most severe operating conditions.

The Gotham line of Mercury Dial Thermometers also includes thermometers in 3½", 4½", 6" and 8½" sizes to suit every type of industrial service. Write today for full information. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

FEATURES:

Thermal System	Stainless Steel
Movement	Corrosion-resistant Brass
Dial	Black or white with contrasting figures and graduations
Case	Drawn Steel
Ring	Brass Friction Fit
Mounting	U-shaped clamp assembly
Connection	Center back with ½" NPT bulb connection
Ranges	All standard Mercury Dial Thermometer ranges
Accuracy	1% of full scale range over middle half of dial.

Quality Gauges Engineered for Enduring Accuracy

USG UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE . . . Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges Boiler Gauges • Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

For more information circle **37** on inquiry card.

IT'S NEW...IT'S NEWS!

...this 360° Bearing Counter

Smaller and more compact than ever, this new 360° Bearing Counter gives users several *bonus* advantages: It can be either base-mounted, or face-mounted flush with a panel surface. It will run at 1500 rpm constant speed or 2500 rpm on intermittent service . . . and it comes equipped with Geneva Transfer.

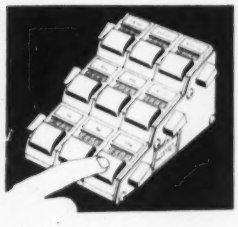
Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This is another Veeder-Root "first" . . . the latest of one of hundreds of standard and special Veeder-Root Counters for every mechanical and electrical application. What do *you* want to count? Write:

ANOTHER NEW VEEDER-ROOT "FIRST"

New *Vary-Tally* Multiple-Unit Reset Counter gives you quick finger-tip count of anything countable. Comes in any combination up to 6 banks high, and 12 units wide (minimum of 2 units wide). Write for news sheet and prices.



VEEDER-ROOT INCORPORATED • HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

For more information circle **38** on inquiry card.

News

Here's SK's NEWEST DESIGN for Rate-of-Flow Measurement— the SAFEGUARD ROTAMETER

As an answer to industry's increasing demands for *safety* and *convenience* in rate-of-flow measurement of liquids and gases, SK has designed its newest Rotameter—the Safeguard Rotameter.

This Rotameter has specific application for measurement in the higher temperatures and pressures of modern process technology, or where dangerous or valuable liquids and gases are being used.

FOR SAFETY:

The completely enclosed steel meter case has detachable safety glass windows, protects the metering tube from external shock, and also protects the operator if accidental tube breakage occurs.

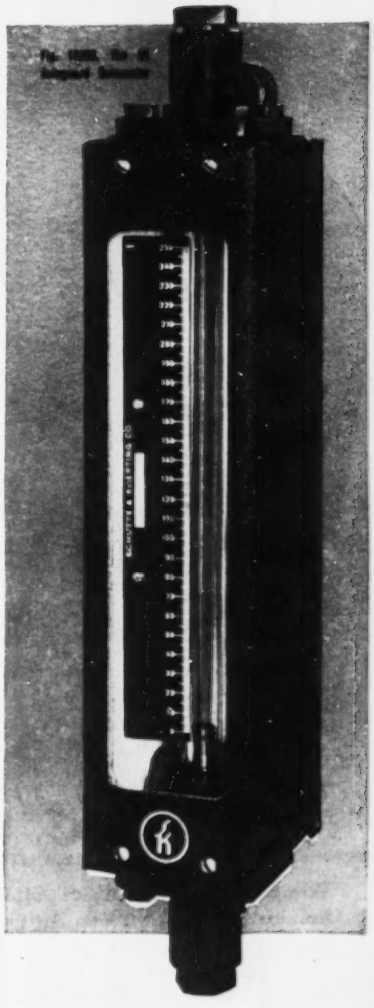
FOR CONVENIENCE:

Wider front and rear sight glass windows give maximum visibility. The detachable metal reference scale can be supplied in either units of flow or in millimeters for use with calibration charts, as desired.

Extreme construction rigidity gives precise end fitting alignment, eliminates pipe stresses on the tube.

Can be adapted for remote recording and controlling of fluid rate of flow.

Write for full information, including sizes and capacities, on this newest Rotameter design.



Glass metering tube has cylindrical inlet and outlet pieces of the *same outside diameter*—allowing use of the same size packing rings on either end of the tube.

Horizontal inlet and outlet can be connected in four different positions.

Two types of metal mandrel made tubes are available—the "HCF," a High Capacity Fluted tube, or the "R," a conical tapered tube without flutes.

Various rotor designs and materials permit wide capacity range within one meter.

End fittings are available in cast iron, bronze, and stainless steel.

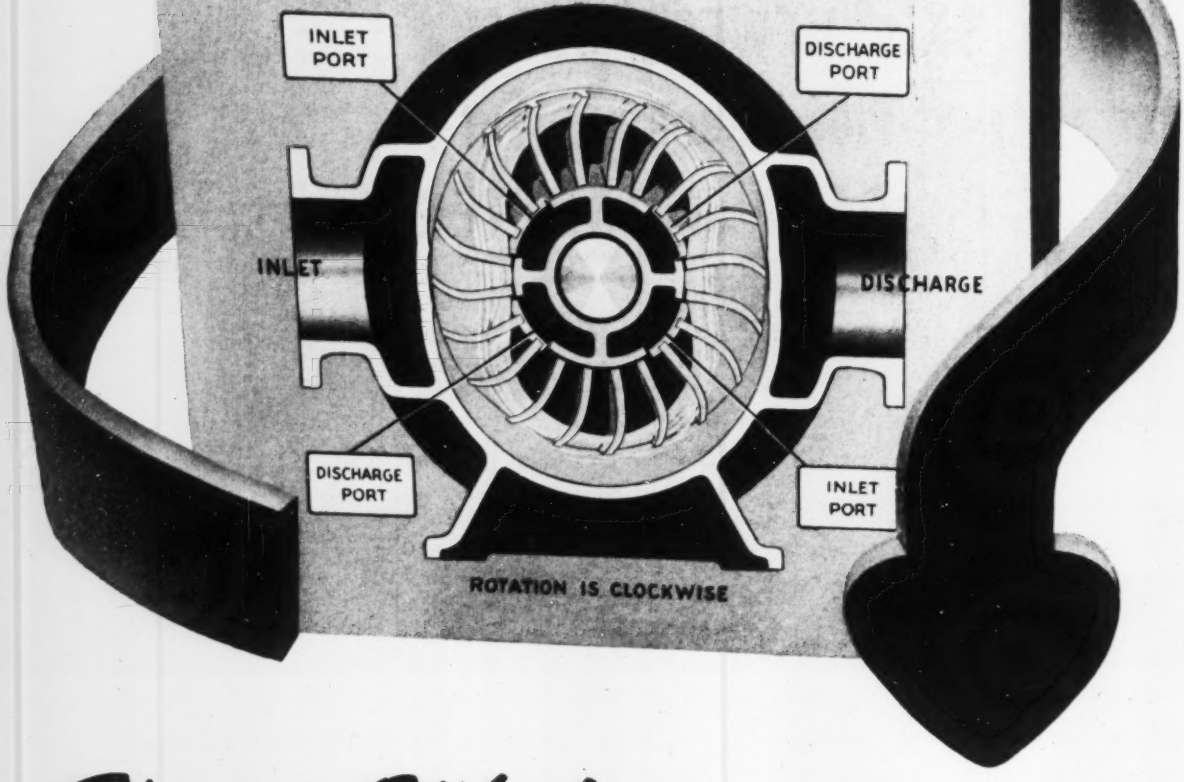
Neoprene packing gives corrosion resistance, tight seal, long service life. Other packing material is available.

Rotor removal and tube cleaning without dismantling easily done through non-leaking seated clean-out plug.

SCHUTTE and KOERTING Company
Manufacturing Engineers
CORNWELLS HEIGHTS
BUCKS COUNTY, PA.

For more information circle **39** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



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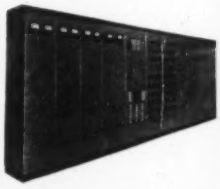
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

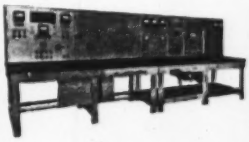
®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



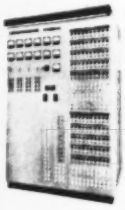
ARMSTRONG CORK CO.



BELL AIRCRAFT CORP.

NASH KELVINATOR

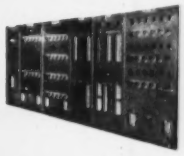
GENERAL ELECTRIC CO.



NAVAL RESEARCH LAB.

ABERDEEN PROVING GROUNDS

LOS ALAMOS
PROVING GROUNDS



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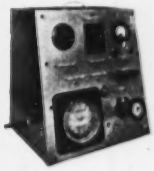
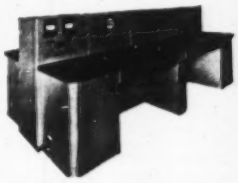
OF AMERICA

SIKORSKY AIRCRAFT

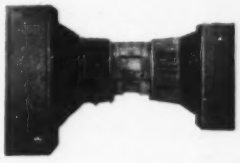


ATOMIC ENERGY COMMISSION

WESTINGHOUSE ELECTRIC CORP.



COMMONWEALTH EDISON CO.



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2-Way Solenoid Valve
for controlling the flow
of Air, Gas, Light Oil,
Water, Brine, Freon,
Methyl Chloride, etc.

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SOLENOID VALVE
shown approximate size

Pipe sizes —
3/8" and 1/2"

Maximum pressure —
Air — 200 p. s. i.

Featuring:

- **Compactness** — 2¾" Face to Face.
  3¼" Pipe center line to top of Solenoid.
  3 13/16" Overall Height.
- **Simplicity** — Only two operating parts: flexible diaphragm and stainless steel core.
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- **Forged Brass Body and Bonnet** insure freedom from porosity.
- **No Corrosion Problems** — All parts in contact with fluids are of brass or stainless steel.
- **Normally Open or Normally Closed** Types Available.
- **Low Power Consumption** — Only 10 Watts!
- **No Jamming or Binding** — No closely fitted parts that can be jammed by solid matter.
- **Nema I Standard or Nema VII** Explosion-Proof Solenoid enclosures.
- **Over Two Years** under Development and Life Test!

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Variable Transformers

TYPE 136 AND 236

provide new higher ratings . . . smaller size . . . easier installation and servicing . . . smoother operation and longer life . . . greater overload characteristics.

POWERSTAT types 136 and 236 are all new . . . new design . . . new performance . . . new ratings. Incorporated into each unit are all the features essential for the ultimate in variable transformers.

Types 136 and 236 are offered for manually-operated and motor driven duty in 120, 240, 480 volt ratings. Here are the reasons they are superior:

- **Higher Ratings:** Type 136 is rated 120 volts, 50/60 cycles input; 0-120/140 volts, 20.0 amperes output.
- **Smaller Size:** "Pancake" coil design provides compactness for bench or panel mounting.
- **Easier Installation:** Three sets of mounting holes suit all needs. Binding post type terminals provide all connection methods.
- **Easier Service:** Simply remove plate block for access to brush assembly. Brush easily removed and replaced.
- **New Rhodium Plated Commutator:** The one best answer to smooth performance and long life. The contact surface remains forever free of oxides. Corrosion is reduced. Uniform contact drop maintained and greater overload characteristics allowed.

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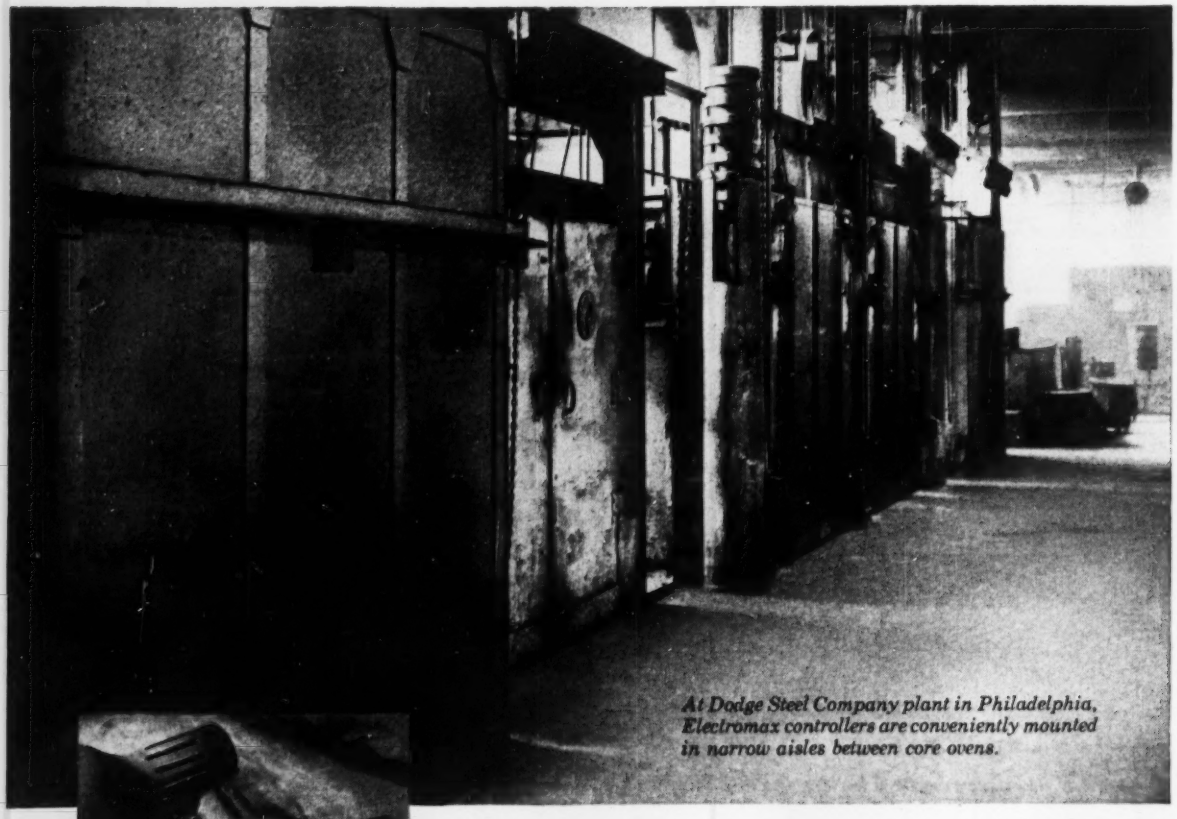
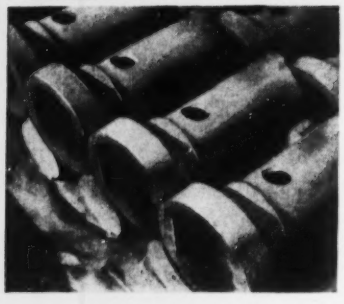


At Dodge Steel Company plant in Philadelphia, Electromax controllers are conveniently mounted in narrow aisles between core ovens.



With drying ovens under Electromax control, danger of either wet or burnt cores is practically eliminated. Cores, above, come out of the oven clean and thoroughly dry.

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Editorial...

THE 1954 IRE NATIONAL CONVENTION AND SHOW

CHIEF POINTS OF INTEREST of a conference usually differ greatly from those of an exhibit, even when the two are held concurrently, because the papers delivered at a conference reflect the activity at the design and development level whereas the exhibited products reflect activity at the commercial level. There can be great time lag between developments at the former level and their use at the latter level, as is exemplified vividly by transistors. For several years a major feature of the IRE conference has been the many papers delivered on the provocative subject of transistors (reflected by exaggerated newspaper and trade-journal announcements that the transistor soon would replace most if not all of vacuum- and gas-type electron tubes). As of 1954, nearly six years after the announcement of the invention of transistors, the same situation exists—with one difference: a few transistors could be seen in operation in commercially available equipment at the exhibit. The 1954 IRE exhibit revealed that the electron tube is in no immediate danger of being supplanted completely by the transistor in any field except where the transistor's unique operating features outweigh the superior economy and proved reliability of the electron tube. However, the challenger has matured to the point where it can at last be considered a serious rival to the champ in particular applications.

Conference Papers

The 243 papers presented at the technical sessions were delivered at 51 sessions, under the basic classifications of communications, aeronautical and navigational electronics, information theory, engineering management, radio telemetry, medical electronics, nuclear science, electron devices, broadcasting, industrial electronics, circuit theory, quality control and reliability, audio, information theory, electronic computers, instrumentation, ultrasonics, antennas, and propagation.

Intense interest was manifest in all sessions, particularly those concerning transistors and computers. Of special significance among the transistor papers were (1) "Wide-band Amplification with Surface-barrier Transistors" by J. B. Angell of Philco, and (2) "Transistor for High-power Applications" by J. S. Saby of GE.

Computer papers of special significance included (1) "Role of the General-purpose Digital Computers in Automatic Control and Information Systems" by A. Cohen of Engineering Research Associates, (2) "Design Features of Current Digital Differential Analyzers" by E. Braun of Librascope, and (3) "Optimized Data Encoding for Digital Computers," by W. Kautz of Stanford Research Institute. The papers on magnetic core materials and magnetic-tape recording of video information aroused great interest. The paper "A Germanium Tape Reader" by R. Langevin of Transistor Products revealed a new tape reader utilizing germanium photoresistors.

Many papers from all sessions were primarily "instrument" papers—(1) "Company-owned Frequency Standard" by J. Smith of Collins Radio, (2) "Phase Measurement in the Video Frequency Range" by Graustein and Houghton, Technology Instrument Corp., (3) "Use of Charged Particles to Measure Skin Thickness and other Surface Properties" by F. Hutchinson of Yale University, (4) "Guided-missile Range Instrumentation" by M. Friedland, Patrick Air Force Base, (5) "Biological Servomechanisms and Control Circuitry" by O. Schmitt of U. of Minnesota, (6) "Optimization of Servosystems" by Lyman and Caywood, Carnegie Institute of Technology, (7) "An X-band Rapid-sweep Oscillator" by Rickert and Dettinger, Wheeler Labs., (8) "A Gaussian Noise Generator for Frequencies Down to 0.01 Cps." by D. Winter, Washington University, (9) "Non-reactor Electronics at Oak Ridge" by P. Bell of ORNL, (10) "Microwave Radiometric Receiver Developments" by R. Ringoen, Collins Radio Co., and many others.

In the field of components, mention should be made of the following papers: (1) "Resolution in Precision Potentiometers" by R. Sullivan, Fairchild Camera & Instrument, (2) "Core Materials for Magnetic Amplifier Applications" by Teasdale & Brownell, Magnetic Metals Co., (3) "Type E1T Decade Counter Tube" by I. Rudich, Amperex Electronic Corp., (4) "A Developmental Thyratron Capable of Current Interruption by Grid Action" by Johnson, Webster, and Olmsted, RCA, (5) "Synthetic Quartz Crystals for the Electronic Industry" by Hale and Charbonnet, Brush Labs. Co., (6) "Improvements in the Field of Electrolytic Capacitors" by D. Altenpohl, Aluminum-Walzwerke Singen, and (7) "Magnetic-core Delay Cables," by D. Stein, Columbia Technical Corp.

Exhibit

Six hundred and four exhibitors displayed more than ten million dollars' worth of electronic equipment and components. This largest radio show ever held under one roof had a mile and a half of exhibits. Needless to say, all types of products were exhibited. A feature of the show this year was reduced emphasis, percentage-wise as compared to previous years, in aircraft electronics (GCA, ILS, radar, etc.), recording, audio, and facsimile. This was accompanied by increased emphasis on electronic instrumentation and components. Lest the impression be given that the subjects with reduced emphasis were neglected, be it reported that one highlight of the entire show was the new fidelity revealed (by Ampex and Audio & Video Products) in stereophonic sound. A new high in realistic reproduction of hi-fi sound can be reported; if such technique can be made economic for the average hi-fi enthusiast, a tremendous new market would develop overnight. This is said literally, not figuratively. The orchestra can indeed be brought wherever the multichannel tape-recorded stereophonic sound system can be carried.

Increased emphasis on instrumentation of all types—except nucleonic instruments—was evident. Thus there is much to report as "newsworthy" in this show report to readers interested in instrumentation.

Computers

Analog computers were better represented than were digital computers. Analog computers were displayed by Boeing, Berkeley, Davies Laboratories, Electronic Associates, Goodyear, and Reeves. The new "Type 635" of Electronic Associates was disclosed, as were the new "C-301 and C-302" desk-top models of Reeves. Greatly expanded use of such computers now awaits only the learning of simple simulation techniques by working engineers in plants and labs.

Digital computers were displayed by Consolidated Engineering, Remington Rand, and Underwood.

Many new accessories and computer transducers were revealed. Giannini disclosed a new analog-to-digital converter, as did Kearfott, Telecomputing Corp., and Helipot. The Helipot "Helipulse" analog-to-digital transducer translates shaft rotation into electrical pulses by moving a slider over a discontinuous coil winding; the Kearfott "Sadac" converter uses rotating drums with conducting and nonconducting segments; the Telecomputing "Digitester and

Digitohm" are essentially complete instruments which utilize a d-c. bridge and chopper amplifier to measure resistances and voltages (with digitized output at laboratory standard accuracy). Telecomputing also revealed a new circuit scanner for 50 and 100 circuits; applications include monitoring and telemetering. By the way, we're in favor of calling "analog-to-digital converters" QUANTIZERS, for that's what they are!

Recording

Many new recording devices were displayed. Texas Instruments revealed a new 2-channel recording milliameter, featuring the TI magnetic-FLUID (not friction-type magnetic) clutch. Ampex revealed a new magnetic-tape seismic drum recorder that makes possible broad experimentation with seismic signals. Consolidated presented the new "Type 5-119" 50-trace recorder; Brush presented the new "BL-256" 6-channel recorder featuring remote control of chart speeds from 1 cm./hr. to 250 mm./sec.; Heiland made a first showing of the "Model 70" subminiature 12-channel oscillograph; Sanborn revealed the new "151-100" single-channel recorder with electric marker, plus a new recorder designed especially for use with analog computers. New multi-channel oscillographs were presented also by Century Geophysical, Edin Co., and Midwestern Geophysical.

The world's largest facsimile recorder was shown in use with Alfax electrosensitive paper.

The Potter "Flying Typewriter" displayed a new magnetic-core storage unit for digital readout; 480 tiny storage elements give 2^6 or 64 decisions, thus calling for any letter or number. The unit is capable of 48,000 characters per minute (digital), or 24,000 characters per minute alpha numeric (numbers and letters). The Potter digital magnetic-tape handler was shown with new high speeds of 60 in./sec. and 5 ms. start/stop times.

Much interest was shown in the *X-Y* function plotters of Librascope and Moseley.

Pulse Instrumentation

The high accuracy and versatility of pulse and digital techniques has led to the development of much new pulse instrumentation. Berkeley Division of Beckman exhibited a new double-pulse generator (the new "Model 5510" EPUT counter and timer, direct-reading to 1 Mc. or 1 usec.), and a new preset counter-controller. Berkeley also exhibited a new "Model 5570" direct-reading frequency meter for 0-42 Mc. This unit, plus converter, gives direct readout to 515 Mc. Electro-Pulse, Inc. exhibited a complete new line of unitized pulse generators, gate generators, and time delays. Burroughs Corp. exhibited a line of pulse control equipment, standard units of which were assembled into a TV sync and color bar generator. Much interest was developed by the Burroughs beam switching tube—essentially ten tubes in one small envelope—which can switch or modulate an electron beam in ten discrete positions. Digital Instrument Company exhibited a 2-Mc. frequency counter. General Radio exhibited a "Type 1217-A Unit Pulser" featuring small size and continuously adjustable pulse durations from 0.2 to 60,000 usec. Among the 14 new test instruments introduced by Hewlett-Packard at the show were several new frequency and electronic counters: the new "524B" counter measures frequencies from 10 cps. to 220 Mc., time intervals from 1 microsecond to 100 days.

Amplifiers

Southwestern Industrial Electronics revealed the new "Model DM-2" d-c. amplifier with frequency response from 0 to above 100 kc. A traveling-wave tube amplifier with 30-db. gain, 1-watt output, and operating at 2 to 4 kilomegacycles was revealed by Hewlett-Packard. A new multichannel amplifier system with response from 0 to above 150 kc., suitable especially for use with oscillograph recorders, was exhibited for the first time by Wm. Miller Instruments. One of the few commercial uses of transistors on display was in the potted transistor "Transamp" audio-frequency amplifiers exhibited by Electronic Research Associates; another transistor application was in the Raytheon 30-watt servo amplifier which uses transistors and magnetic amplifiers. A new high-temperature (200 deg. C.) fast-response magnetic amplifier was exhibited by Freed Transformer.

Weston Electrical Instrument displayed the new "Model 1475" multi-range "Inductronic" d-c. amplifier for low-level measurements. Also new was the Weston "Product Resolver"—a dynamometer movement plus "Inductronic" amplifier and indicator—and an integrating fluxmeter.

Motors

New lines of control and instrument motors were exhibited by Servomechanisms, Borg, and Servo-Tek. Servomechanisms presented a new line of 400-cycle control motors, with or without adjustable damping; Servo-Tek presented a new line of p-m. miniature motors and generators, also motor controllers. The new Borg motors, synchronous and induction, were designed especially for recorders, timers, and instruments.

Other timing devices were exhibited by R. W. Cramer, Sessions Clock, and Telechron.

Power Sources and Supplies

A new line of tubeless electronic voltage standards were revealed by Sorensen—an a-c. instrument for calibrating oscilloscopes, and a d-c. voltage standard for replacing power supplies and standard cells in recording equipment. New miniaturized power packs for transistor applications were displayed by Electronic Research Associates. Servo Corporation of America revealed a new 5000-volt d-c. sup-

ply. New "Powerstat" variable transformers, featuring high ratings in small space, were featured by Superior Electric Co. Freed Transformer revealed a new magnetic (tubeless) a-c. voltage regulator.

Test Instruments

Beckman's new Shasta Division revealed a complete new line of electronic test instruments—the Shasta "Model 301" audio oscillator, "Model 601" high-resistance bridge, "Model 202" a-c. VTVM, and "Model 201" electronic voltmeter. Beckman also introduced the new "Arga Models 100 and 101" expanded-scale a-c. VTVM's. Freed Transformer introduced a new "Type 1620" megohmeter with variable d-c. test potential of 50 to 1000 volts. Hickok Electrical Instrument made a first-showing of the new "Model 700" laboratory tube tester in which all voltages are variable and indicated, making it possible to duplicate tube-manual data. Sensitive Research Instrument displayed the interesting new "DC Laboratory Standard," said to be the first with accuracy of 0.05 percent in measuring currents from 1 ma. to 30 amps. and voltages from 100 mv. to 3000 v. A "preview" showing was made of the new "Model 6 Resistance Meter" of Southwestern Industrial Electronics, with range from 0 to 10 million megohms; also the SIE "Model N" oscillator wtih range from 3 cps. to 3.3 Mc.; this large range is covered by a single Wien-bridge-type circuit.

The "Servoscope" servo analyzer of Servo Corporation of America was shown with expanded ranges of 0.2 to 60 cps., of particular interest to industrial instrument men. Another new industrial instrument was the Brush tension analyzer for recording tension from 0.1 to 400 g. in any filamentary material at high speeds. Still another industrial instrument was the new "Temprobe" thermistor-element surface pyrometer of Victory Engineering, featuring response time of 5 to 20 sec. The display of thermistor, varistors, and thermal-conductivity cells of Victory attracted much interest.

A brief listing of other new instruments exhibited at the show includes: "Model 901" transconductance analyzer and circuit simulator of New London Instrument Co. (this tube tester has facilities for externally connecting electronic components so that the tube can be tested in the circuit in which it is to be used); ultrasonic test equipment of Gulton Manufacturing which can check materials both with and without flaws by measuring the attenuation in the material; low-frequency (0.1 to 4.5 Mc) frequency meter of Measurements Corp.; explosion-proof ITV monitor of Decade Instrument; "Model D-79" gaussmeter of Dyna-Labs for flux fields of 10 to 30,000 gauss; automatic test and sorting equipment of Industrial Instruments, Inc.; phase meters of Industrial Test Equipment; delay lines and magnetometers of Laboratory for Electronics; "Series 600" oscilloscope of Spencer-Kennedy Labs; *Q* standards of Boonton Radio, with known *Q*'s to within 3 percent; navigational computer of Ford Instrument; "Model S-6-A" broad-band "Pulsescope" of Waterman Products; and several new DuMont oscilloscopes—"Types 329, 301-A, and 323." Space does not permit detailed description of all these new instruments, but all have been (or will be) reported in the New Instrument Department of this magazine.

Relays

All components, including relays, were well represented at the show. Assembly Products featured their new plug-in "meter-relays" (d'Arsonval movement plus relay); James G. Biddle exhibited their new frequency-sensitive relays that respond to only a narrow band of frequencies; Thomas A. Edison, Inc., introduced a new sensitive (25-microwatt) relay "Model 219," featuring fixed-coil moving-magnet construction. Other new relays were exhibited by Advance Electric & Relay Co., Automatic Electric Sales, A. W. Haydon (time-delay relays), G. H. Leland (rotary solenoids and relays), Neomatic, Inc., Potter & Brumfield (featuring the new "PW" miniature relay), and Stevens-Arnold (who also featured their new d-c.-to-a-c. 60-cps choppers). A new line of 400-cps. choppers was introduced by Airpax Products.

Precision Potentiometers (Voltage Dividers)

The precision potentiometer (voltage-dividing resistor) is finding vast use as a basic transducer in computers and instruments of all types. Fairchild Camera & Instrument introduced the new "Type 771 Filmpot" metallic-film-type unit featuring infinite resolution. Another new film potentiometer was revealed by Servomechanisms, Inc.—the "Pot-100," offered in linear and nonlinear film potentiometers. Electro-Mec Laboratory revealed their new "Types 20 and 30" function units. A first showing of the new "900 Series Micropots" was made by George W. Borg; these featured 3-turn, 10-turn, and ganged models. Bourns Laboratories exhibited a new dual "Twinpot" linear-motion screw-driver operated units with two outputs, and also new, miniature pressure-operated VDR pickups for up to 3000 psi. differential at 1000 psia. A new "Spiralpot" (a low-cost version of the precision multi-turn pot) was introduced by Giannini. Helipot Corp. exhibited a new "Series V Helipot" featuring continuous rotation and as many as 25 ganged sections.

Transistors

As expected, the transistor displays by General Electric, Germanium Products, Minneapolis-Honeywell, and Texas Instruments were of great interest. The commercially-available "2N57" power transistor of M-H is of particular interest to industrial users, as are the new junction tetrode transistors of Texas Instruments (said to be the first available in quantity). TI also revealed experimental power transistors, plus new grown-junction germanium transistors, silicon junction diodes, and phototransistors.

Other components

Delay lines were exhibited by General Electric (distributed-constant line featuring constant delay up to 4 Mc. and providing delays up to 10 usec.), Electronic Computer Div. of Underwood (lumped-parameter lines for delays up to 1100 usec.), and Helipot. Helipot exhibited the new "Helidel" distributed-constant line for delays to 0.2 usec.

The new modular technique for automatic production of circuits was exhibited via the "Reliacube" and "Reliapack" units exhibited by Sanders Associates.

Other new components of specific instrument interest include subminiature filters of Burnell & Co., subminiature toroids and miniature transistor transformers of Freed Transformer, new printed-circuit "Continental" connectors of DeJur-Amsco, new printed microwave plumbing of Airborne Instruments Laboratory, new "Telesyn" sine-cosine resolvers and miniature mechanical differentials of Ford Instrument, and new GE thermistor kits for temperature experimentation. The Mallory mercury batteries and "Silverlytic" capacitors designed especially for transistor circuits were also of interest.

Magnetic Materials

Indiana Steel Products exhibited the new "Indox 1"—a ceramic magnet. Arnold Engineering exhibited the new "Vibralloy"—a ferromagnetic alloy with a controllable temperature coefficient of modulus of elasticity.

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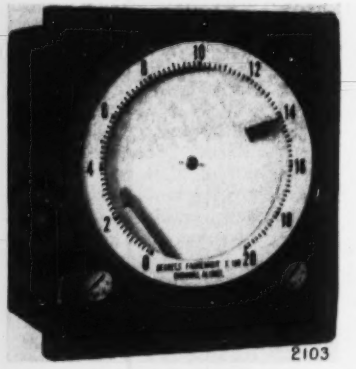
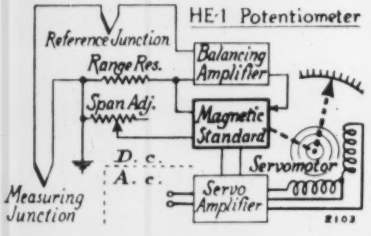
PROCESS CONTROL

Process Recorders and Recorder-controllers

New "HE" line comprises six initial offerings: "HE-1" potentiometric recorder, "HE-2" potentiometric recorder with electric control, "HE-3" potentiometric recorder with pneumatic control, "HE-11" a-c. bridge recorder, "HE-12" a-c. bridge recorder with electric control, and "HE-13" a-c.



bridge recorder with pneumatic control. Instruments are self-balancing; embody new measurement circuitry and components, among which are: (1) In new potentiometer system, magnetic standard obviates need of standard cells, dry cells and moving parts; provides continuous standardization without periodic interruptions



of measurement or control. (2) In a-c. bridge instruments, bridge-balancing unit supplies power to bridge and provides a means for rebalancing it. Among other features are plug-in components, anti-backlash gearing, internal illumination, various electric-control forms from on-off to proportional-position. Available pneumatic control forms: (1) proportional band from 1 to 500 percent; (2) reset rate 0.02 to 12 repeats/min.; (3) rate times 0.02 to 10 minutes.—*Meter & Instrument Dep't, General Electric Co., 40 Federal St., West Lynn 3, Mass.*

For more information circle **201** on inquiry card.

Hydrogen Sulphide Recorder

New "Type SU Hydrogen Sulphide Detector" comprises (1) Recorder with chart scaled in parts per million; (2) Combined sampling and primary-measuring unit: (*a*) detection chamber, (*b*) paper feed, (*c*) stain-period timer, (*d*) motor, (*e*) sequence relays, (*f*) gas flow controller; (3) Glass tube flowmeter to check required gas sampling rate. Audible and visual alarms can be added if requested. Recorder scale factor can be adjusted between 0.05 ppm. for full-scale (highest sensitivity) and 200 ppm. for full-scale.—*Viking Instruments, Inc., East Haddam, Conn.*

For more information circle **202** on inquiry card.

Conductivity Cells

New electrolytic conductivity cells are for use with maker's "Dynalog Conductivity Instruments." Low-conductivity cells (constants of 1, 0.1,

and 0.01) are available in two types, both for insertion in a pipeline or a tank, one type removable under pressure without interrupting process. High-conductivity cells (constants of 10 and 100) are also furnished in two types, one for insertion, the other a dip type for open tanks. Cleaning is simplified and fouling minimized.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **203** on inquiry card.

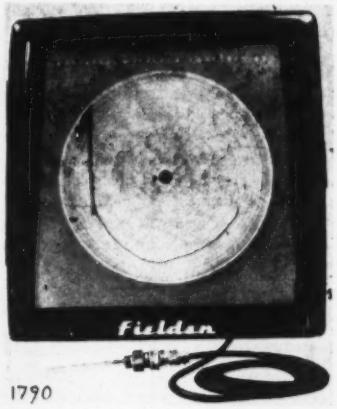
Automatic Shut-off for Pneumatic Systems

New automatic device locks control valves, dampers, etc. in a pneumatic system in event of a lowering or failure of air pressure; prevents valves from going wide open or closed with consequent process and control disruption. Spring-loaded diaphragm has supply pressure on one side and system pressure on the other. Lowering or failure of supply pressure unbalances diaphragm to close needle valve in control line and lock controlled valves, etc., in position. Non-corrodible construction throughout.—*Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.*

For more information circle **204** on inquiry card.

Recorder-controllers

New recorder-controllers are for applications including temperature, conductivity, strain, force, position; pressure; and for telemetering. Feature is simplified unit assembly principle: recorder is composed of four readily interchangeable units. Instruments operate on null-balance principle using a-c. signal actuation, require no batteries or standardizing circuits. Bridge unit permits range changing



and recorder's adaptation to different measurements; is available with up to four inputs, permitting averaging, addition or differentiation. Nickel, tungsten, and platinum resistance thermometers cover from –200 C. to 500 C. (–328 F. to 932 F.). A full range of control forms, both electric and pneumatic, is available.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

For more information circle **205** on inquiry card.

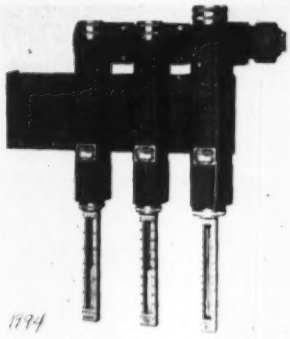
Argon Purity Analyzer

New analyzer continuously records purity of argon gas with accuracy of 0.01 percent; is supplied with two scales: (1) For normal operating, full-scale range of 99-100 percent argon to measure purity of finished product; (2) auxiliary range of 80-100 percent argon to measure crude argon or while starting up purifying column. Instrument is self-contained, ready for use after making current and sample connections. It operates by comparing thermal conductivity of a sample with that of a known standard. Measuring cells are replaceable and interchangeable.—*Thermo Laboratories, Johnson Rd, Michigan City, Ind.*

For more information circle **206** on inquiry card.

Process Gas Controller

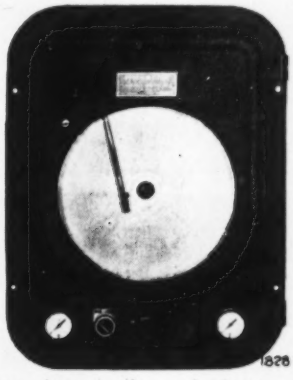
New "Nicarbo-Guard," for measurement of carrier, enriching gas and ammonia in carbo-nitriding process, can be used with any type of furnace properly designed for carbo-nitriding; also for controlling carrier and enriching gas for straight carburizing. Developed exclusively for these uses, it is available in ten standard sizes. Control valves are built into top of each flow-meter where operator can see exactly what he is doing. Unit includes "Waukee Mixing Manifold" which saves piping time and pipe fittings.—*Waukee Engineering Co., 407 East Michigan St., Milwaukee 2, Wis.*



For more information circle **207** on inquiry card.

Viscosity-control Recorder

New "Model R2P Recorder for Pneumatic Control" provides two output air pressures, one a function of the measured viscosity and the other the control set point pressure. Indicating air gages for each air pressure and an adjusting knob for control point air pressure make new recorder conveniently usable with standard 3-15-psi. controller.—*Norcross Corp., Newton 58, Mass.*



For more information circle **208** on inquiry card.

Industrial TV Camera

New "Kay-Lab Television Camera System" is said to produce "the ultimate in flexibility and reliability" through unitized design; is usable either as an industrial TV inter-communication system or in commercial broadcasting for remote, studio or film pick-up. Camera, camera control, and synchronizer monitor, are basic units of system which employs advanced techniques heretofore unavailable in moderately priced equipment. Camera can be held in palm of hand, can

WELCH VACUUM GAUGES

McLEOD-High Vacuum Type

No. 1453

Scale range 30 microns—Smallest calibration .005 micron.
Direct reading logarithmic scale.
Scales ruled on heavy white celluloid.

Tubes can be readily cleaned by direct mechanical operation where necessary, due to the unique construction of large openings directly in line with the capillary tubes.

Mounted on all-metal heavy base.
Complete as shown, but without mercury.

EACH $235.00

DUBROVIN-Direct Reading Type

ECONOMICAL—SIMPLE TO USE
UNIQUE MAGNIFIED SCALE

This Gauge is principally a straight glass tube mounted on a metal base. The lower half of the tube is filled with mercury, in which is immersed an indicating float. As the air is evacuated through the outlet provided in the upper part of the glass tube, the indicator shows pressure variations directly on the scale.

1451 C. DUBROVIN GAUGE TYPE A table model, 20 mm. range, 6 to 1 scale, without mercury	**Each, $44.50**
1451 E. DUBROVIN GAUGE TYPE B table model, 20 mm. range, 9 to 1 scale, without mercury	**Each, $52.50**
1451 J. DUBROVIN GAUGE TYPE B wall model, 20 mm. range, 6 to 1 scale, without mercury	**Each, $44.50**
1451 J. DUBROVIN GAUGE TYPE B wall model, 20 mm. range, 9 to 1 scale, without mercury	**Each, $52.50**

No. 1451C

Also made from Pyrex brand tubing at the same prices.

W. M. WELCH Scientific Company
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
ESTABLISHED 1880

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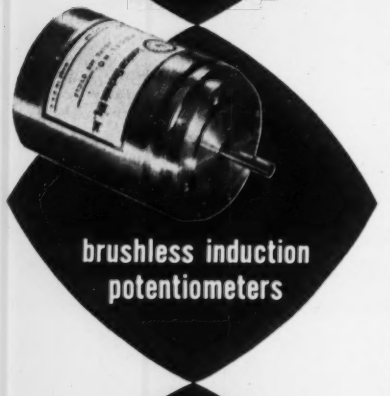

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Let us quote on your detailed requirements.

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8503 W. JEFFERSON BLVD., CULVER CITY, CALIF.
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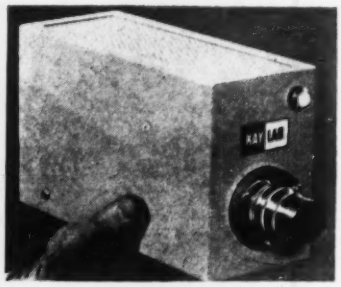
For more information circle **45** on inquiry card.

NEW INSTRUMENTS

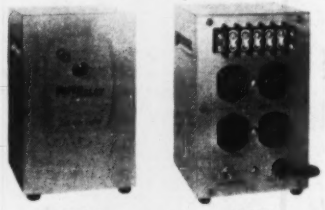


be operated continuously in factory, with all its electrical adjustments controlled remotely at camera control up to 500 ft. away.—*Kalbfell Labs*, 1090 *Moreno Blvd., San Diego* 10, *Calif.*

For more information circle **209** on inquiry card.

Automatic-control Relay

New "Super Relay," for constant-temperature baths, constant-pressure control, or photoelectric counting, control or alarm systems, controls loads



of 15 amps. ac, with an input current of less than 5 microamperes; permits desired phase of control with completely "fail safe" operation of controlled device. D-c. vacuum-tube circuitry is said to provide maximum stability as well as provision for external delay circuits if needed for optimum control characteristics.—*Chicago Apparatus Co.*, 1735 *N. Ashland Ave., Chicago* 22, *Ill.*

For more information circle **210** on inquiry card.

PRESSURE

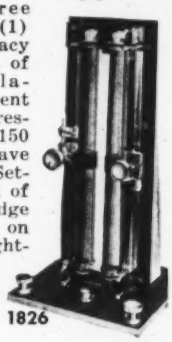
Pressure Pickup

New "Model GP-8 High Range Pressure Transducer" is a reluctance type pickup available in ranges from 200 to 5000 psig. (all rated at 100 percent safe overload); suitable for static and dynamic measurements: natural frequency from 2000 cps. at lowest range to 10,000 cps. at highest. Resistance to mechanical vibration and shock excitation: acceleration response in most sensitive axis is less than 1 percent full-scale per 1000 *G* in all ranges above 1000 psi. Pressure-measuring diaphragm is integral with steel body. Electrical characteristics: any excitation frequency from 60 to 50,000 cps.; maximum input voltage at 3000 cps. 30 v.; full scale output 40 mv. per volt input in bridge circuit operation. Accuracy (including linearity) 1 percent full-scale or better.—*North American Instruments, Inc.*, 2420 *N. Lake Ave., Altadena, Calif.*

For more information circle **211** on inquiry card.

Precision Manometer

New "Model M-12" manometer for calibrating flowmeters is 18 in. high, was developed to comply with the following three specifications: (1) Over-all accuracy to be 0.0015 in. of water; (2) relatively convenient to use; (3) pressures up to 150 psig. Tubes have ¾-in. bores. Setting mechanism of double black edge type is used on each leg for sighting on bottom of meniscus. (Settings by this method to within 0.0002 in. by an experienced operator.) Inches and tenths are read on center scale; and hundredths and thousandths are read with vernier on steel scales. Magnifying lens in front of each vernier. —*National Instrument Laboratories, Inc.*, 6108 *Rhode Island Ave., Riverdale, Md.*

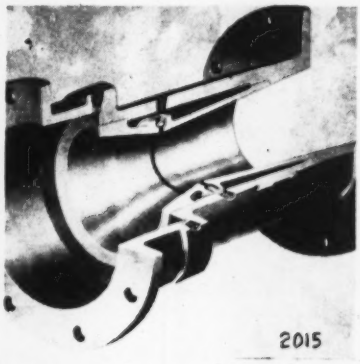


For more information circle **212** on inquiry card.

FLOW

Flow-rate Primary Element

New "Dall Flow Tube" is a differential producer for use with gases and liquids carrying no settleable solids. A short flanged cylindrical body with an abrupt decrease in diameter



is followed by a conical restriction and diverging outlet: reduced area at cone entrance, together with design of annular throat, induces high differential pressure and diverging outlet cone provides high recovery. Among features: Lowest permanent head loss of any known differential producer of velocity increaser type; short length and low weight for easy installation. —*Builders-Providence, Inc.*, 345 *Harris Ave., Providence* 1, *R. I.*

For more information circle **213** on inquiry card.

Pocket-size Gas Meter

New "Gas Volume Meter" is a pocket-size instrument which measures volume of any gas passed through it, utilizing principle of positive displacement. As gas is introduced into instrument a set of rotors turn. Their rotation is then carried through timing gears, a gear train, to calibrated dial which indicates in large circle cubic centimeters and in small circle liters. Instrument's accuracy is within 5 percent between 5 and 65 liters per minute flow-rate. Instrument comes in a Royalite carrying case; recess in case for each part.—*J. J. Monaghan Company, Inc., 500 Alcott Street, Denver, Colorado.*

For more information circle **214** on inquiry card.

Liquid and Slurry Regulator

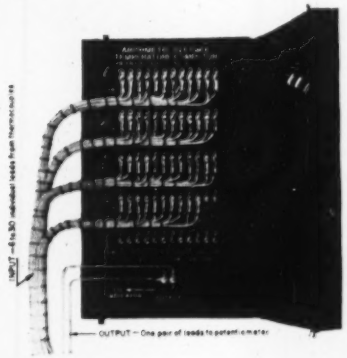
New "Type SA" series regulators are especially designed to control flow rates of liquids and light slurries. Capacity range of "Model 7SA" is 50 to 275 gpm, yet unit measures 13 in. diam. and 30 in. high. Other models have capacity ranges down to 2 to 10 gpm. All units will handle variations in inlet-to-outlet pressures of as much as 125 psig. with 3 percent accuracy or better.—*W. A. Kates Co., 430 Waukegan Rd., Deerfield, Illinois.*

For more information circle **215** on inquiry card.

TEMPERATURE

Average-temperature Computer

New "Automatic Arithmetic Average Temperature Computor" is available in two models. One instantly gives



CHATILLON
SPRING DESIGN "KNOW-HOW" IMPROVES FAIRCHILD AERIAL CAMERAS

FAIRCHILD CAMERA AND INSTRUMENT — HOUSING LANE — SYOSSET, LONG ISLAND, NEW YORK

March 18, 1954

John Chatillon & Sons
85-91 Cliff Street
New York 38, N.Y.

Attention: Mr. M. Gerard Fangemann
General Manager, Spring Division

Dear Mr Fangemann:

We wish to extend our sincere appreciation to you for the splended technical assistance and know-how rendered in furnishing us with a very difficult, precision music wire spring used in our Aerial Camera Shutter

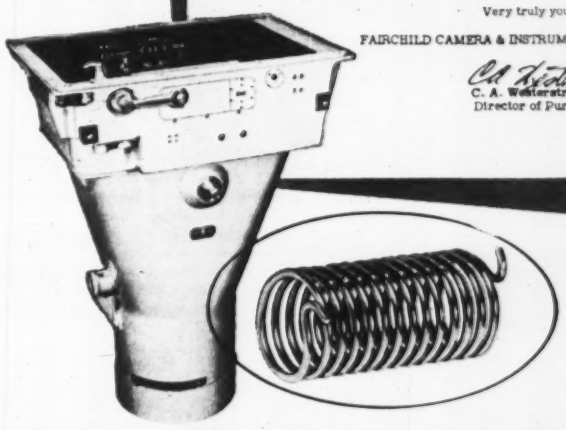
Our specifications require that 450 degrees of windup will produce a torque of 42 inch ounces with a tolerance of ± 4 inch ounces and due to space limitations the wire is so highly stressed that absolutely no bending nicks or surface imperfections can be tolerated.

This type of work is beyond the realm of ordinary spring manufactures and we wish to thank you for the excellent cooperation your company has given us.

Very truly yours,

FAIRCHILD CAMERA & INSTRUMENT CORPORATION

C. A. Westerstrom
Director of Purchasing



Faced with a particularly difficult spring problem in designing their new Aerial Camera Shutter, the Fairchild Camera and Instrument Corporation called in the capable Engineering Staff of the Spring Division of John Chatillon & Sons. The solution was swift and accurate . . . an outstanding example of the careful quality control employed by Chatillon in the development of springs meeting their most most rigid specifications.

Chatillon specializes in the manufacture of all types of precision springs, making use of all spring alloys. Our temperature-compensated alloy called "Iso-Elastic"*—a noteworthy Chatillon development—is used extensively in the instrument field where constancy of spring characteristics is imperative with changes of temperature.

Why not give Chatillon the opportunity of improving your designs as we did for Fairchild? Contact the Chatillon Spring Division and request engineering bulletins on Chatillon Iso-Elastic Springs.

*U.S.A. PAT. No. 2174171

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N. Y.
Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **46** on inquiry card.

A Revolutionary New Relay Development

of utmost importance to electrical and electronic design engineers

The Mullenbach Capaswitch uses an entirely new and different concept in relay design to transfer the contacts; *provides extreme sensitivity, low power requirements, high current-carrying capacity.*

The revolutionary new Capaswitch is basically an ultra-sensitive relay with unusual current carrying capacity. It will perform all of the jobs of conventional magnetic-coil relays, within the same current carrying capacity, plus many jobs that magnetic-coil relays cannot do. However, in design it departs radically from conventional relays. Instead of the usual electromagnetic armature, *a unique electrostrictive capacitive element provides the mechanical energy to open and close the contacts.* Only 0.5 milliwatt-seconds of operating power (150 volts d.c.) is required to close the contacts. To keep them closed requires less than 0.1 milliwatt, *or less than one-hundredth the power required to keep a conventional magnetic-coil relay closed!* This low power requirement opens up a vast new field of applications, eliminating need for much pre-amplified equipment.

How the Capaswitch works—Application of an actuating voltage creates a bending moment in the electrostrictive capacitive element, closing the contacts. Removal of the actuating voltage and discharge of the electrostatic element through external circuits or through a resistor, removes the bending moment, opening the contacts.

Time Delay Function—If appropriate resistances are applied in the circuit, the Capaswitch will function as a time delay relay to open or close the contacts. For longer time delays a larger condenser may be paralleled to the capacitive element.

Pulse Characteristics—Initial closing time of the Capaswitch is 10 milliseconds. However, it can be actuated by pulses as short as 10 microseconds or less. The electrostatic element may also be used to store low power pulses until sufficient voltage has been accumulated to operate the relay. However, present models cannot be used for accurate counting.

High Overvoltage Capacitance—Absence of a coil enables the Capaswitch to withstand wide voltage variations. As much as 200% overvoltage may be applied to the electrostatic element without damage. Low power requirements virtually eliminate heat and resulting dissipation problems, and reduce the number of needed components, saving space and weight.

Available now—Until recently the Capaswitch has been available only in limited quantities. Now, however, stepped-up production schedules assure increasing supplies.

OVERALL DIMENSIONS:
Length: 3½"
Width: 1-7/16" including solder terminals
Depth: 11/16"
Weight: 1.7 ounces

THE MODEL A-150 CAPASWITCH
a single pole, double throw relay, rated at 1 amp., 110 v., A.C. non-inductive load. Normal operating voltage 150 volts D.C.

Write today for complete specifications and prices!

Mullenbach
ELECTRICAL MANUFACTURING CO.
Established in 1927
2300 East 27th Street • Los Angeles 58, Calif.

For more information circle **47** on inquiry card.

average temperature of 5 to 20 thermocouples (in engine test cells, etc.) where temperature is indicated on a potentiometer. The other gives average temperature of 5 to 30 TCs. Either can be so installed that (a) each thermocouple may be observed or (b) average may be obtained at will. Time saving is said to be such that instrument "will pay for itself in only a few days."—*Aero Research Instrument Co.*, 1901 *N. Hermitage Ave., Chicago 22, Ill.*

For more information circle **216** on inquiry card.

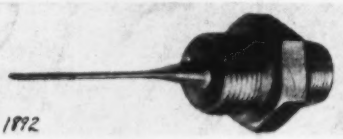
Safety Feature for Pyrometer Controllers

New safety monitoring feature has been incorporated in new model of "Protect-O-Vane" millivolt-type pyrometer controller. It is designed as an auxiliary controller to shut down a process not only when there is an excess temperature condition but also in event of instrument component or power failure. New cut-off feature can be incorporated into existing controllers by replacing plug-in control unit. —*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **217** on inquiry card.

Resistance-thermometer Bulb Assembly

New "Model 221 N 90 A" hermetically-sealed electrical-resistance thermometric primary element, for use with temperature recording, indicating and control equipment where fast response is required, has a detector characteristic time of 0.8 second or better in an agitated water bath. Stainless steel housing and a glass-to-metal seal for electrical connection resist corrosion. Range —70 C. to 200 C.; accuracy 1 percent or better in mid-scale.—*Thomas A. Edison, Inc., Instrument Div., West Orange, N. J.*



For more information circle **218** on inquiry card.

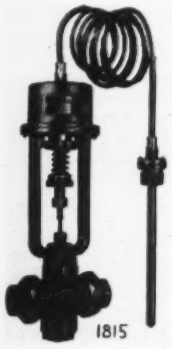
Rotary-output Thermal Primary Element

New "Rotary Thermal Actuator" converts a temperature change into a rotational movement, to actuate a potential divider or produce torque for other purposes. Model shown operates in range 50 F. to 200 F.; has a spring rate of 0.06 oz. in. per 10-deg. angular movement; is made entirely of non-magnetic materials except for bimetal element. Non-magnetic miniature ball bearings can be used where extraordinary sensitivity is required. —*Anthony Mfg. Co., Inc., 407-409 Main St., East Orange, N. J.*

For more information circle **219** on inquiry card.

Temperature Controller

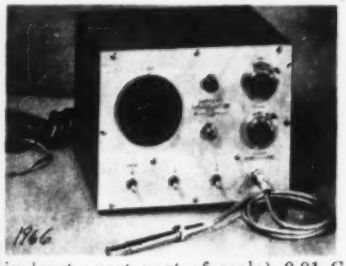
New "SFS Steam Regulator" is a temperature controller with a self closing safety feature which prevents overheating through an override by accidental damage to thermostatic element (which is of vapor tension type and comes with 6 ft. of armored capillary tubing, copper thermal bulb and tank bushing).—*Lawler Automatic Controls, Inc., 453 N. Mac-Questen Pkway, Mount Vernon, N. Y.*



For more information circle **220** on inquiry card.

Temperature Controller

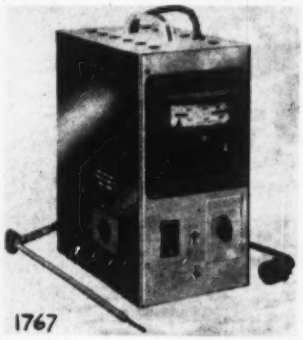
New "Thermonitor Model S" is a thermistor-actuated non-interrupting proportional-action temperature controller, for oil or water baths up to 15 liters. Range 0-100 C.; sensitivity (in least exact part of scale) 0.01 C. Three standard heater outlets for plug-in connection of immersion heaters, one of which can be used for connecting a circulating device.—*E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Illinois.*



For more information circle **221** on inquiry card.

Temperature Controller

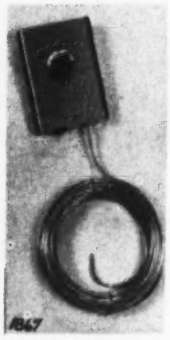
New "Safe-Temp Portable Electronic Controller-Indicator" is usable as an automatic temperature controller or excess temperature cut-off (manual reset), or to verify temperatures of controllers in use. Where atmosphere is hazardous or corrosive "Safe-Temp" may be remote wall mounted. Available in two scale ranges, with either Chromel-Alumel or iron-Constantan thermocouple.—*Blue M Electric Co., 308 W. 69th St., Chicago 21, Ill.*



For more information circle **222** on inquiry card.

Home-heating Regulator

New "3-Way Weather-Flo Small Home Heating Regulator" measures both outdoor and house temperatures; causes burner to be operated just enough so that temperature of air or water circulated is raised only high enough to offset heat loss. It is applicable to gravity or forced flow; requires about one hour to install on an existing burner or on a new building; is claimed to save up to 15 percent of fuel. Outstanding operating feature is said to be that "hot-cold hot-cold characteristic of ordinary room thermostat is replaced by a smooth flow of heat." —*Automatic Devices Co., Western Springs, Illinois.*



For more information circle **223** on inquiry card.

Fire-alarm Flasher

New 'T-173-A Pulsitometer," for use in combined alarm circuits of aircraft, enables pilot to distinguish between sources; operates from 12 or 29 volts; withstands jet-aircraft vibrations; weighs 6½ oz.—*Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles 39, Calif.*

For more information circle **224** on inquiry card.

ACCELERATION

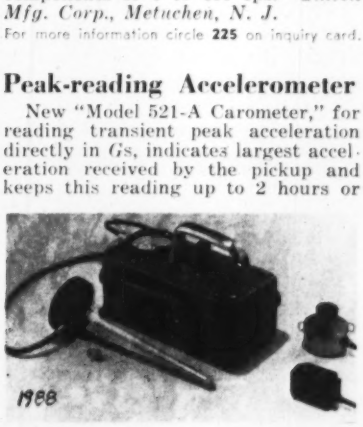
Recording Accelerometer

New recording accelerometer for rockets, missiles, aircraft and other difficult applications is self-contained; has no external connections; features a built-in tape recorder. Size only 3½ x 4 x 2½ in.; weight less than 42 oz. Unit is constructed to withstand high forces and impacts. It records accelerations up to 60 *G* with frequency components of 0 to 400 cps.—*Gulton Mfg. Corp., Metuchen, N. J.*

For more information circle **225** on inquiry card.

Peak-reading Accelerometer

New "Model 521-A Carometer," for reading transient peak acceleration directly in *Gs*, indicates largest acceleration received by the pickup and keeps this reading up to 2 hours or



NEW

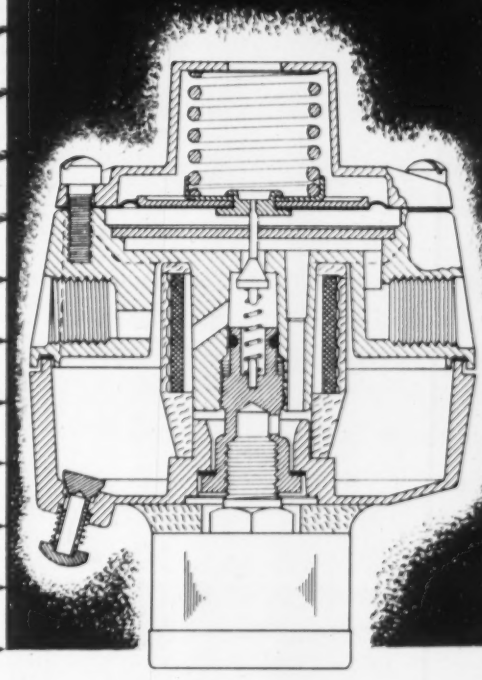
KENDALL
FIXED-OUTPUT
REGULATOR

Designed Especially for Instrument Air Supply Service

Kendall's New Model 50 is ideal for flow up to 10CFM or dead-end service because of its sturdy, tamper-proof construction combined with the filter-dripwell feature and drift-free characteristics.

FEATURES AND ADVANTAGES

- SMALL SIZE 4⅛" HIGH x 3⅜" DIAMETER
- RUGGED CONSTRUCTION: BUILT TO LAST
- LARGE FREE FILTER AREA 35 x STANDARD ¼" PIPE AREA
- HIGH DRIPWELL CAPACITY
- NO FILTER INTERFERENCE
- CAN BE SUPPLIED WITH PRESSURE GAUGE
- VENTURI ASPIRATION
- 150 LB. SUPPLY PRESSURE
- STAINLESS STEEL VALVE SPRING
- SELF-CONTAINED SAFETY RELIEF VALVE
- PUSHBUTTON DRAIN VALVE
- COMPETITIVELY PRICED



ADJUSTABLE MODEL 55

For use where frequent adjustment of output pressure is required. Can be either panel or pipe mounted. Equipped with bronze threaded bushing for hex head adjustment screw or handwheel screw. Available in ranges from 2 to 100 p.s.i.

FOOLPROOF BECAUSE IT'S TAMPERPROOF

Investigate Kendall's new fixed output regulator today. Send for further technical information. Outline your requirements and ask for prices.

"Engineered Air Regulation"

KENDALL CONTROLS CORP.
144 MOODY ST. WALTHAM 54, MASS.

For more information circle **48** on inquiry card.

higher speed scanning than ever before

with the

KYBERNETES ELECTRONIC SCANNING SYSTEM*

Any number of points scanned 60 times per second!

•

Completely electronic.

•

No moving or mechanical parts.

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Accuracy of ± 2%.

•

Scanning uninterrupted by read-out or alarm.

•

THE KYBERNETES CORP.
(division of Self Winding Clock Co., Inc.)
1100 RAYMOND BOULEVARD
Newark 5 • New Jersey
(Opposite PRR Station)

(*Patent applied for.)

For more information circle **49** on inquiry card.

NEW INSTRUMENTS

until reset to zero. Three ranges: 0.1, 1 and 10 *G* (approx. 0.1, 1 and 10.0 volts) full-scale. Frequency response approx. flat from 7 to 70 cps.; can be extended by removing filter and with suitable frequency compensations added.—*The Victoreen Instrument Co., 3800 Perkins Ave., Cleveland 14, Ohio.*

For more information circle **226** on inquiry card.

Miniature Rate Gyro and Acceleration Pickup

New miniature gyro indicates angular rates from 0.05 to 120 deg./sec. Accelerometer in an identical package measures accelerations from 0.01 to 25 *G*. Both instruments meet high standards for reliability under shock and vibration. Various models of both are available having different performance characteristics, and for 400 or 1000 cps.—*Equipment Eng'g Div., Raytheon Mfg. Co., 148 California St., Newton 58, Mass.*

For more information circle **227** on inquiry card.

TIME, SPEED AND COUNTING

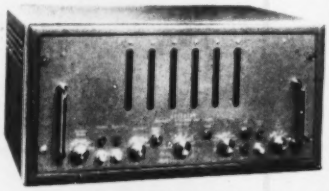
Engine Time Recorder

New "D.C. Hour Log" provides an operating record for portable and stationary engines; operates on direct current; can be used on tractors, trucks, road graders, etc., to tell operator when to inspect for overhaul, lubrication, etc. It is tamperproof and completely sealed.—*Engler Instrument Co., 250 Culver Avenue, Jersey City, N. J.*

For more information circle **228** on inquiry card.

Counter and Timer

New "Model 5510 Universal Counter and Timer" is capable of (1) measuring and indicating time intervals from 3 usec. to 1,000,000 sec. with



accuracy of 1 usec.; (2) measuring and indicating frequencies from 0 to 1 Mc. with accuracy of 1 cycle; (3) measuring period of frequencies from 0 cps. upwards with accuracy of 1 usec.; and (4) operating as a straightforward electronic counter at rates up to 1,000,000 cps. Maker's "705AF" and "707AF" decimal counting units provide binary coded output information for data reduction applications.—*Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.*

For more information circle **229** on inquiry card.

Time-interval Indicator

New "Type PTM-100 Picco Timechanism" indicates duration in elapsed time of an applied electrical

signal to "an extremely high degree of accuracy." It operates on 27.5 v.dc.; withstands acceleration, vibration and shock encountered in supersonic flight. Outer scale is calibrated in 1/100 sec.; inner scale in seconds. Dial markings and sweep hands are luminescent.—*Picco Instruments & Controls Corp., 3593 Hayden Ave., Culver City, Calif.*

For more information circle **230** on inquiry card.

Thermal Delay Relays

New light-weight thermal delay relays for industrial, aeronautical, mobile and marine applications are available in 6.3 v., 26.5 v. and 117 v. ac-dc. with delays of 5 to 300 sec. at 25 C.; can be adapted to any control requirement not covered by available types. Contact rating for relays with delay periods up to 75 sec., 3 amps at 150 v.dc. or 250 v.a.c.; 105 sec. or more, 3 amps at 450 v.ac.dc. Contacts are silver s-p.s-t. either n-o. or n-c. Max. seated over-all height, 3.25 in. New relays operate in an arc-quenching atmosphere within a standard T9 radio tube envelope. All units can be operated continuously. By using inherent cooling interval of n-o. relay, operation of certain electrical circuit elements can be continued after main circuit has been broken.—*Sheldon Electric Co., 69 Coit St., Irvington 11, N. J.*

For more information circle **231** on inquiry card.

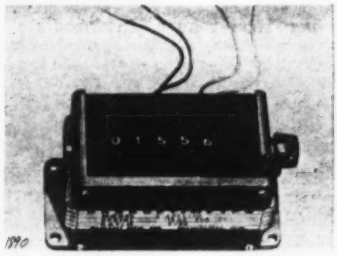
Motor Speed Controllers

New speed controls for shaded-pole motors feature elimination of magnetic noises; operate within temperature rises allowed by Underwriters Laboratories; are designed for motors up to 220-v. 60-cps. up to 3 amps. In most cases they will provide low, medium, and high speeds for particular unit to be controlled. They will be available for mounting into existing outlet boxes; also flush, wall, and rear-of-panel mounting.—*Curtis Development & Manufacturing Company, 3266 33rd St., Milwaukee 16, Wis.*

For more information circle **232** on inquiry card.

Predetermined Counter

New "SP-MF" is said to be "the first electrically-operated Predetermined Counter to be offered on the market." Available in either four or

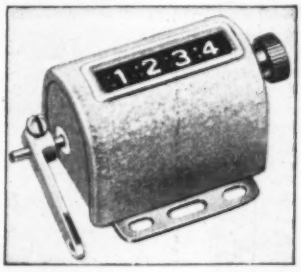


five figures, models are actuated by electric impulses to close or open a switch at any pre-set count from 1 to 9999 or 1 to 99999 respectively.—*Durant Mfg. Co.*, 1914 *N. Buffum St., Milwaukee* 1, *Wis.*

For more information circle **233** on inquiry card.

Stroke Counters

New "Junior Kings" are small, reset, stroke counters developed especially for built-in applications on of-



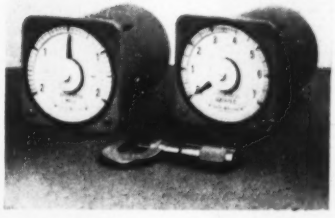
fice machines and light production equipment.—*Production Instrument Co., 702 W. Jackson Blvd., Chicago 6, Ill.*

For more information circle **234** on inquiry card.

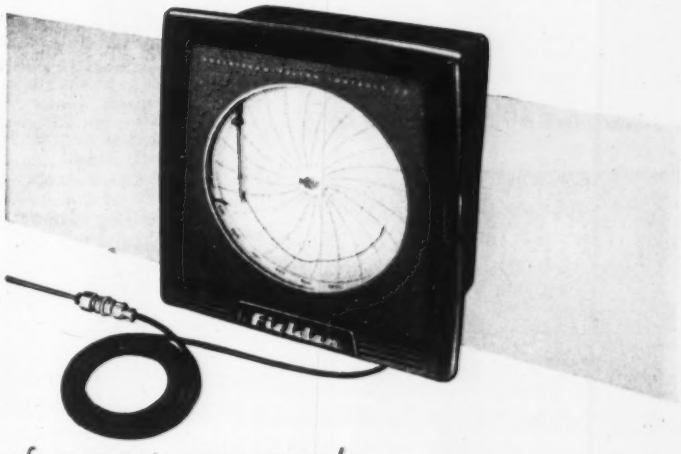
COMPUTING

Integrating Instruments

Two new integrating instruments reduce statistical analysis to slide-rule calculation; aid solution of quality control problems; permit rapid determination of such data as average thickness and standard deviation of textile-fiber tested samples. They differ from conventional electrical indicating instruments in absence of control springs and in high damping. When current ceases to pass through coils, pointers stop instantly. Lead-



can you really buy high accuracy at low cost?



of course you can! This new Fielden Resistance Thermometer Recorder, for instance, measures temperatures up to 950°F. with an inherent accuracy of ±0.5% of full scale! But it sets a new price standard because . . .

. . . we've eliminated the usual design complexities. For example, this self-balancing type recorder uses an AC-actuated bridge circuit that eliminates direct current source and replacement of dry cells. An interchangeable measuring unit permits change in range or measurement without re-wiring. The complete recorder is assembled from only 5 easily replaceable and interchangeable sub-units.

This is Fielden simplified instrumentation—all the accuracy you can possibly use—at an economical price. Mail the coupon for full details.

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Robertshaw-Fulton

CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
2920 N. 4th St., Dept. A, Philadelphia 33, Pa.

Send full details on Fielden simplified:

- ☐ TEKTOLOG Electronic Recorder
- ☐ TELSTOR Electronic Level Indicator
- ☐ TEKTOR Electronic Level Control
- ☐ Resistance Thermometer Recorder
- ☐ MULTIPOINT Recorders
- ☐ Series 97 Temperature Controls

*Name*_____
*Title*_____
*Company*_____
*Address*_____ *City*_____ *State*_____

Fielden TEKTOLOG Recorder

Fielden TELSTOR Indicator

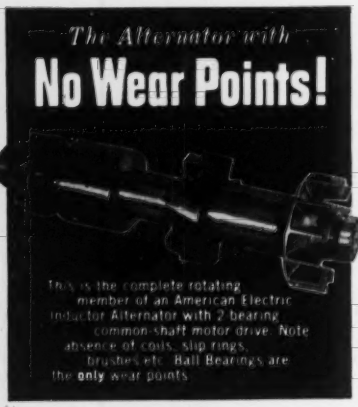
Fielden TEKTOR Control

For more information circle **50** on inquiry card.

TROUBLE-FREE 400 CYCLE * POWER SUPPLIES

with American Electric

INDUCTOR ALTERNATORS

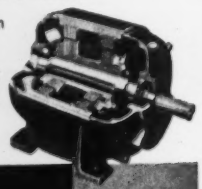

The Alternator with
No Wear Points!
This is the complete rotating member of an American Electric Inductor Alternator with 2 bearing common-shaft motor drive. Note absence of coils, slip rings, brushes etc. Ball Bearings are the only wear points

Most rotary electrical equipment is subject to wear...*in windings, slip rings, brushes, springs or other working parts.* But here's an alternator with *NO WEAR POINTS* other than two ball bearings! Even these are grease-sealed; lubricated for life.

With American Electric's exclusive Inductor Alternator design you can forget maintenance, forget trouble! Write for details and power ratings.

**Also available in other fixed frequency ranges or in variable frequency models.*

Here's how the American Electric Inductor Alternator is built. Note all windings are stationary. Output is taken directly off stationary windings. Even the excitation is fed to a stationary winding (center coil)!



Many Model Variations:

- 2 Bearing Common Shaft
- 4 Bearing Belt Driven
- 4 Bearing Direct Connected
- Variable Speed Driving Units

FEATURES

Low Harmonic Content, Compact Design, Quiet Operation, High Power Factor

STATIONARY OR PORTABLE DESIGNS for laboratory, ground, production, missile and all other high frequency uses.

FIXED AND VARIABLE FREQUENCY MODELS!

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Exclusive Sales Agents: TRAVCO ENGINEERING CO. *Los Angeles, Silver Spring (Md.), Boston, New York City, Buffalo, Chicago, Dallas, Kansas City, Seattle, Minneapolis, Montreal, Toronto.*

For more information circle **51** on inquiry card.

NEW INSTRUMENTS

in spirals being torqueless, circuits are furnished to reset pointers to zero. Two models: (1) current integrating instrument with p-m.m-c. mechanism; speed of pointer at any instant proportional to current flowing through coil at that instant. Rated from minus 85 to plus 85 milliampere-seconds; responds adequately to instantaneous current values from 0.03 ma. to 6 ma. (2) Current-squared integrating instrument, dyanometer-type driving mechanism: pointer speed proportional to square of current; responds adequately to instantaneous current values from 1.5 to 30 ma.—*Meter and Instrument Dep't, General Electric Co., 40 Federal St., West Lynn 3, Mass.*

For more information circle **235** on inquiry card.

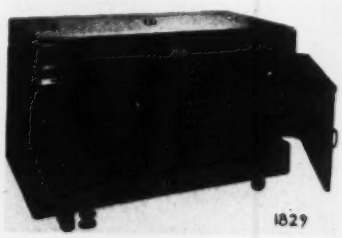
Integrating Instrument

New "Anadige" is said to be a new type of electronic integrator, for integration of transient electrical phenomena to "accuracy previously unobtainable from commercial sources." It may also be used for integration of long-duration phenomena where extreme accuracy is desired. Input impedances of any value may be used and such primary elements as strain gages, photocells, thermocouples, accelerometers, etc., may be accommodated. Input may be either a voltage or a current signal. Functionally, "Anadige" is a quantizer which converts a continuous input to a number of pulses corresponding to area under magnitude-vs.-time curve. Claimed advantages: (1) accuracy of integration relatively independent of vacuum-tube characteristics; (2) integrator has a higher resolution and therefore a higher accuracy than that obtained from analog or mechanical devices; (3) relatively free of drift; (4) ease of calibration. Output pulses of "Anadige" may be totalized on any conventional digital or glow-tube counter calibrated in desired units. Physically, "Anadige" is of plug-in construction.—*Mega Research, P. O. Box 371, Dover, N. J.*

For more information circle **236** on inquiry card.

Digital Computer

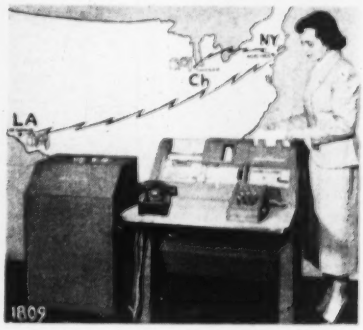
New "Circle Computer" is a low-cost electronic digital computer suited to needs of research lab or engineering firm; features ease of maintenance and simplicity of operation; contains 700 vacuum tubes; consumes 3½ kw. (110-v. single-phase); is built up from small logical units, each on a removable separate chassis and all easily accessible for checking while computer is operating. Magnetic drum memory element has capacity of 1024 words; each of forty binary digits plus two sign digits—equivalent to 12 decimal digits plus sign. Multiplication time is 45 milliseconds. All controls for operation appear on operator's console. In addition, neon lights allow operator to monitor computer's course in a calculation. Input is by electric typewriter or punched paper tape reader. Intermediate as well as final results are available. —*Nuclear Development Associates, Inc., 80 Grand St., White Plains, N. Y.*



For more information circle **237** on inquiry card.

Card-data Transmitter

New "IBM Transceiver," said to be the first punched-card transmitter that "talks" over regular telephone circuits, features a rate of almost 1,000 alphabetic or numeric characters per minute, can also check accuracy of its "conversations" by "listening-in" on them. Operation: as it reads cards, it generates coded impulses ("beeps"), each series of sounds representing a hole in card. These sound signals actuate punching mechanism in distant receiver, which simultaneously creates exact duplicates of cards being transmitted.—*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*

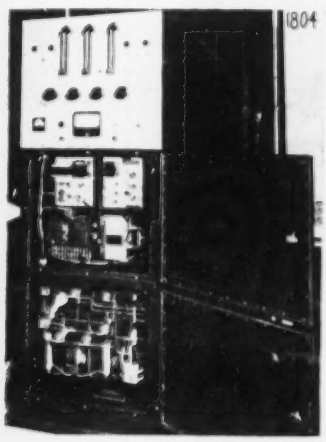


For more information circle **238** on inquiry card.

NUCLEONICS

Radiological Gas Analyzer

New "Hallikainen-Shell Development Radiological Gas Analyzer" is adapted for continuous analysis of binary gas mixtures by measurement of ionization produced in gas by beta radiation from a radioactive source. Source is strontium-90, an abundant

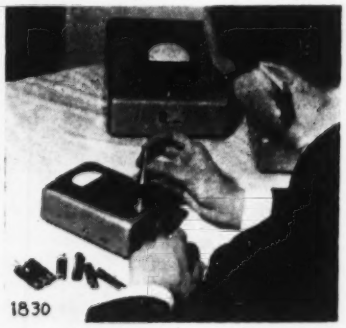


and inexpensive fission product with a relatively long half-life, emitting only beta radiation, thus minimizing shielding problem.—*Hallikainen Instruments*, 1341 *Seventh St., Berkeley, Calif.*

For more information circle **239** on inquiry card.

Radioactivity Dosimeter

New type of personal dosimeter contains a capacitor in series with an Ohmart Cell ("the world's first atomic-powered battery"). When exposed to nuclear radiation, current gener-

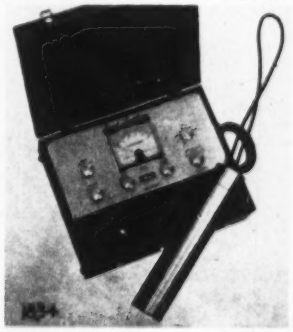


ated by Ohmart Cell is stored in capacitor. Charge accumulated on the capacitor is a measure of radiation to which dosimeter has been exposed. —*Ohmart Corp.*, 2340 *Ferguson Rd., Cincinnati 38, Ohio,*

For more information circle **240** on inquiry card.

Portable Radioactivity Counter-ratemeter

New "Model 118 Royal Scintillator" will define limits of an oil field and locate uranium deposits; also has uses in lab; can be operated from an air-

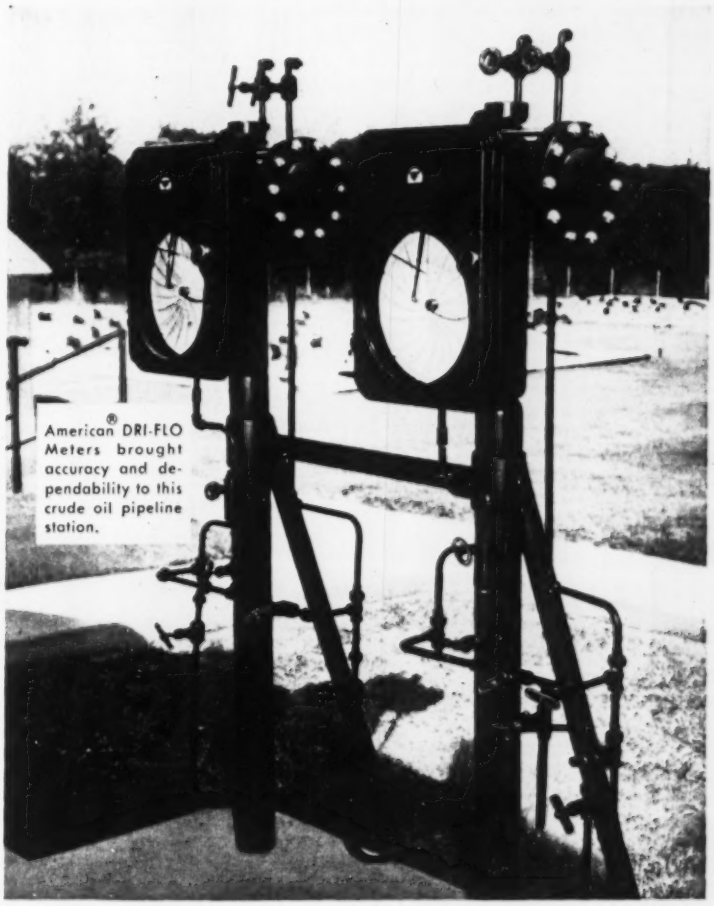


craft or a moving vehicle; incorporates a scaling circuit as well as a ratemeter. Ranges 0.01 to 1.0 mr/hr.; counting rate 500,000 pm.—*Precision Radiation Instruments, Inc.*, 2235 *South La Brea Ave., Los Angeles 16, Calif.*

For more information circle **241** on inquiry card.

Portable Radioactivity Counter-ratemeter

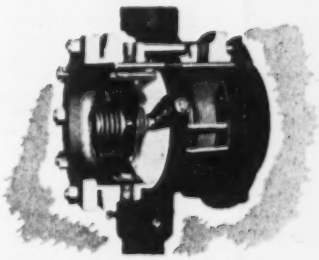
New "Model CAX37P Scintiscope" is a portable scintillation counting survey meter, applicable to an extremely wide range of activity levels. Eight range settings give full-scale readings from 0.05 to 500 r/hr. Case can be carried over user's lower chest by belt and shoulder straps. Four-position indexing attachment makes available several standardized arrangements for calibrating, assay work and monitoring. Standard probe



Do you have a tough metering problem?

Installed at Mid-Continent Pipe Line Company's booster station at Seminole, Oklahoma, these two American DRI-FLO Meters measure high pressure (900 PSI) crude oil in the pipelines to the Company's Tulsa Refinery.

Meter accuracy and dependability are completely satisfactory despite constant vibration and the "tough" nature of the job. No seal pots are required, eliminating "blown" seals and emulsified mercury. Because of the close proximity (70 feet) to the discharge of the booster pumps, the meter pipestands are mounted in a concrete platform and are specially braced. Meter indications, read from the office window, help dispatchers quickly locate troubles such as line breaks, pump or valve failures—and eliminate running high pressure oil lines to the dispatchers office.



DRI-FLO Meters bring American-Westcott precision, simplicity of installation and maintenance, with maximum resistance to corrosive material, to applications where mercury manometers are not desired. Differential ranges: 20", 50", 100" and 200"; working pressures to 1000 PSI; Ambient temperatures of −25° to 175°F.

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AMERICAN METER COMPANY

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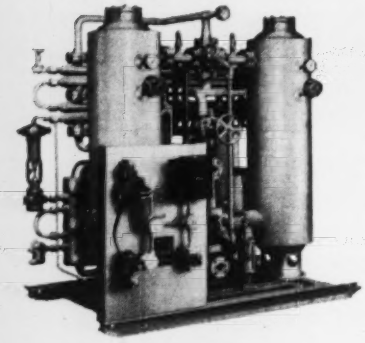
Edmonton • Calgary

For more information circle **52** on inquiry card.

Pritchard
HYDRYER



IT ELIMINATES
MOISTURE PROBLEMS

This dependable Pritchard dehydration unit—a packaged dryer proved efficient in all types of industrial, processing and laboratory installations—reduces moisture content of air or other gases to desired dew points. That eliminates a lot of your moisture problems . . . gives you a good reason for owning a HYDRYER*. There are other good reasons, all of which will save you money.

Here are examples: A HYDRYER will eliminate costly plant and equipment shutdowns due to moisture and ice; it will protect precision instruments and controls; it will reduce corrosion, line losses, flow stoppages.

*Registered Trade Name

To find out all about HYDRYERs . . . and the many ways they can benefit you . . . write for your copy of Prichard's new HYDRYER bulletin, No. 16.0.081.

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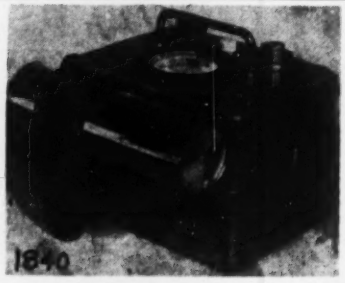
COOLING TOWERS • SPECIALIZED HEAT EXCHANGERS • GAS & AIR TREATING EQUIPMENT

For more information circle **53** on inquiry card.

NEW INSTRUMENTS



is designed for gamma detection. Snap-on phosphors for alpha, beta or neutron counting are available.—*R-C Scientific Instrument Co., Inc., 307 Culver Blvd., Playa del Rey, Calif.*

For more information circle **242** on inquiry card.

PHOTOGRAPHY, ETC.

Miniature Camera

New "Super Ikonta IIIB" redesigned addition to "Ikon Super Ikonta" cameras, weighs 24 oz., produces a dozen 2¼-in. square negatives on a 120-film roll; is equipped with a built-in coupled range-finder and view-finder combination; may be had with a choice of either "Tessar" f/3.5 or "Novar" f/3.5, 75-mm. focus coated lens mounted in a "Synchro Compur" shutter with speeds up to 1/500th second and full (MX) internal flash synchronization.—*Carl Zeiss, Inc., 485 Fifth Ave., New York 17, N. Y.*

For more information circle **243** on inquiry card.

Flash Unit

New "Emtu flash unit is designed specifically to accommodate new miniature size G.E. M2 flash lamp. Reflector contour provides maximum light efficiency from M2. Space for two pen-light batteries behind reflector. Unit's shoe fits accessory clip of most cameras. Three accessory clips on sides mount additional units. Manual switch for open flash; socket to accept standard flash cords or appliance plugs.—*Burke & James, Inc., 321 S. Wabash Avenue; Chicago 4, Ill.*

For more information circle **244** on inquiry card.

Flashtubes

New "Amglo Ultra-high Efficiency Flashtubes," make possible lighter-weight power packs or more light for

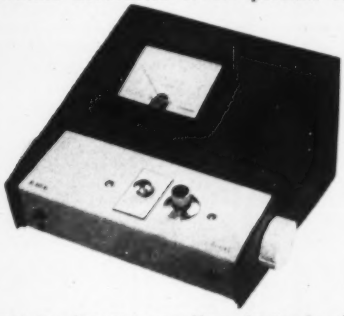
same power; have reflective bases of tarnish-proof Alzak aluminum, resilient Neoprene bushings, focal point adjustable without removal of Pyrex cover glass; higher power ratings and extended tube life: now 50,000 to 100,000 flashes.—*Amglo Corp., 2037 W. Division St., Chicago, Ill.*

For more information circle **245** on inquiry card.

LABORATORY INSTRUMENTS

Clinical Colorimeter

New clinical colorimeter features direct-reading, "pinpoint beam" optics and simplified operation; achieves routine accuracies of 0.5 percent or

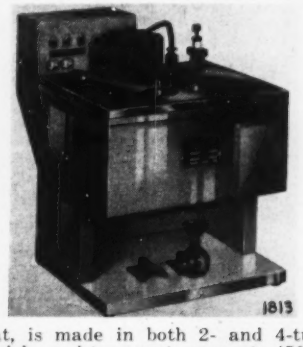


better; instant reading instead of slow swings of ordinary galvanometers; and use of a linear high-vacuum phototube instead of barrier-layer photocell. Its 0.35-0.66-micron range can be extended with a red-sensitive phototube if desired.—*Beckman Instruments, Inc., South Pasadena 1, Calif.*

For more information circle **246** on inquiry card.

Saybolt Viscosimeter

New "Constant Temperature Saybolt Viscosimeter," employing electronic circuit with mercury thermo-



stat, is made in both 2- and 4-tube models, and temperatures up to 450 F.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **247** on inquiry card.

Melting-point Apparatus

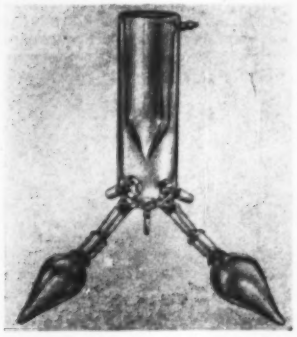
New model of "Fisher-Johns" melting-point apparatus embodies improvements: (1) control unit and heating stage combined into one unit ready for instant use; (2) controls simplified, with a variable transformer now graduated in percent power input;

(3) stage is illuminated. Accuracy, without calibration, is within 1 to 2 deg. C.; with calibration, 0.5 C.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

For more information circle **248** on inquiry card.

Dry-and-freeze Apparatus

New "Lyophilizing Unit," for quick drying and freezing of organic tissues, is particularly useful in biological or

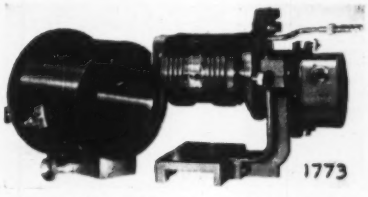


organic chemistry, and medical labs. Lyophilizing time within six hours for full (400-ml.) capacity. Furnished complete with four receiving flasks.—*Wakefield Industries, Inc., 5108 W. Grove St., Skokie, Ill.*

For more information circle **249** on inquiry card.

High-temperature X-ray Diffraction Powder Camera

New "Model HC-101 High Temperature X-ray Diffraction Powder Camera" has a movable film carrier



that allows five 7-mm. diffraction patterns to be made on same film, facilitating determination of phase diagrams and registering comparison patterns of different substances at selected temperatures to 1000 C. Film carrier, 114.6-mm. diam. with 20 range continuous from 7 deg. to 173 deg. may be removed from furnace assembly at any stage of investigation without disturbing thermal environment of powder sample. Coiled helix furnace heating elements are of platinum-rhodium. Furnace's heating and cooling curves are simple exponentials with about 4-min. constant.—*Central Research Labs., Inc., Red Wing, Minn.*

For more information circle **250** on inquiry card.

Console-model Comparator Microphotometer

New console-model "JAco Comparator-Microphotometer" offers performance improvements and mechanical innovations. Desk-height cabinet, foot control for drive and left-hand positioning of panel switches (which frees right hand for writing and plate marking); sensitivity sufficient to

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For more information circle **54** on inquiry card.

INCREASED ADAPTABILITY!

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PRESSURE SWITCH

Designed for use as a standard gauge pressure switch or as a pressure differential control. the Giannini Pressure Switch provides genuinely dependable service—especially in aircraft or industrial applications involving control system actuation or pressure warning.

Actuating tolerance will not exceed 1% of actuating pressure at 25°C. Contact life of at least 25,000 operations at rated loads. Overpressures up to 3000 psi without affecting operating tolerance. Will not vary more than 3% between −55°C and +71°C.

Pressure range factory-set anywhere between 10 psi and 200 psi.

•

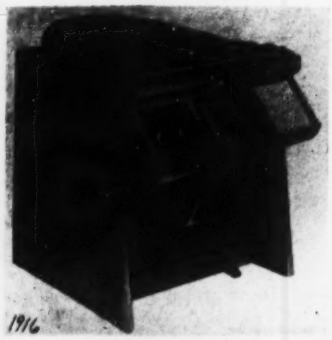
We'll be pleased to furnish additional information on this pressure switch—or on a variation to meet your individual needs. Write us, without obligation, of course.

Giannini

G. M. GIANNINI & CO., INC.
ElectroMechanical Division
East Orange • New Jersey

For more information circle **55** on inquiry card.

NEW INSTRUMENTS

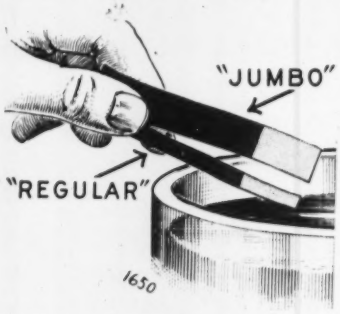


yield full-scale deflection for effective slit size of 1 micron x 0.7 mm. (700 square microns) or better. Speed 4 lines per minute or better. Spectrum visible at all times during scanning cycle.—*Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.*

For more information circle **251** on inquiry card.

pH Test Papers

New "Jumbo Series" of maker's "Hydrion" pH Test Papers provides strips more than twice as wide as regular "Hydrion" and rolls are 600

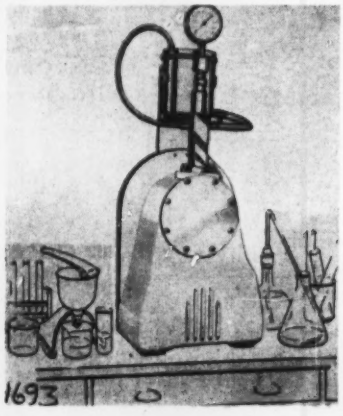


in. long (regular length 180 in.) Furnished in large transparent plastic dispenser; refill rolls also packaged in transparent plastic.—*R. P. Cargille Laboratories, Inc., 117 Liberty St., New York 6, N. Y.*

For more information circle **252** on inquiry card.

Laboratory Homogenizer

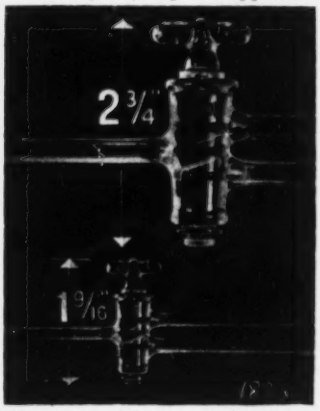
New portable high-pressure laboratory homogenizer is said to incorporate every requirement for laboratory processing and testing. Complete separation of product from drive mechanism. Materials processed in a closed system and at no time exposed to atmosphere. Pressures to 3000 psi. and higher. Process quantities from 1 cc. to 25 gallons per hour. No packing or stuffing boxes, no porous leather or fibre.—*C. W. Logeman Co., 633 Bergen St., Brooklyn 17, N. Y.*



For more information circle **253** on inquiry card.

Micro Stopcocks

New stopcocks for micro operations are available in various shapes; reduce dead space; improve appearance.



Plugs are precision ground and interchangeable. Bores are precision drilled, 1/2, 3/4 and 1-mm. diam.—*Microchemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.*

For more information circle **254** on inquiry card.

DIMENSIONAL

Nine-piece Gage-block Set

New nine-piece set of "Ultra-Chex Gage Blocks" offers 331 different combinations in sixty-fourths and thousandths. Blocks are accurate to within 5 microinches.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **255** on inquiry card.

Precision Level

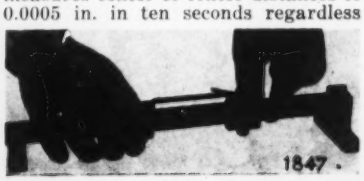
New "No. 59 Master Precision Level" has a graduated vial of ten-second accuracy, with one division

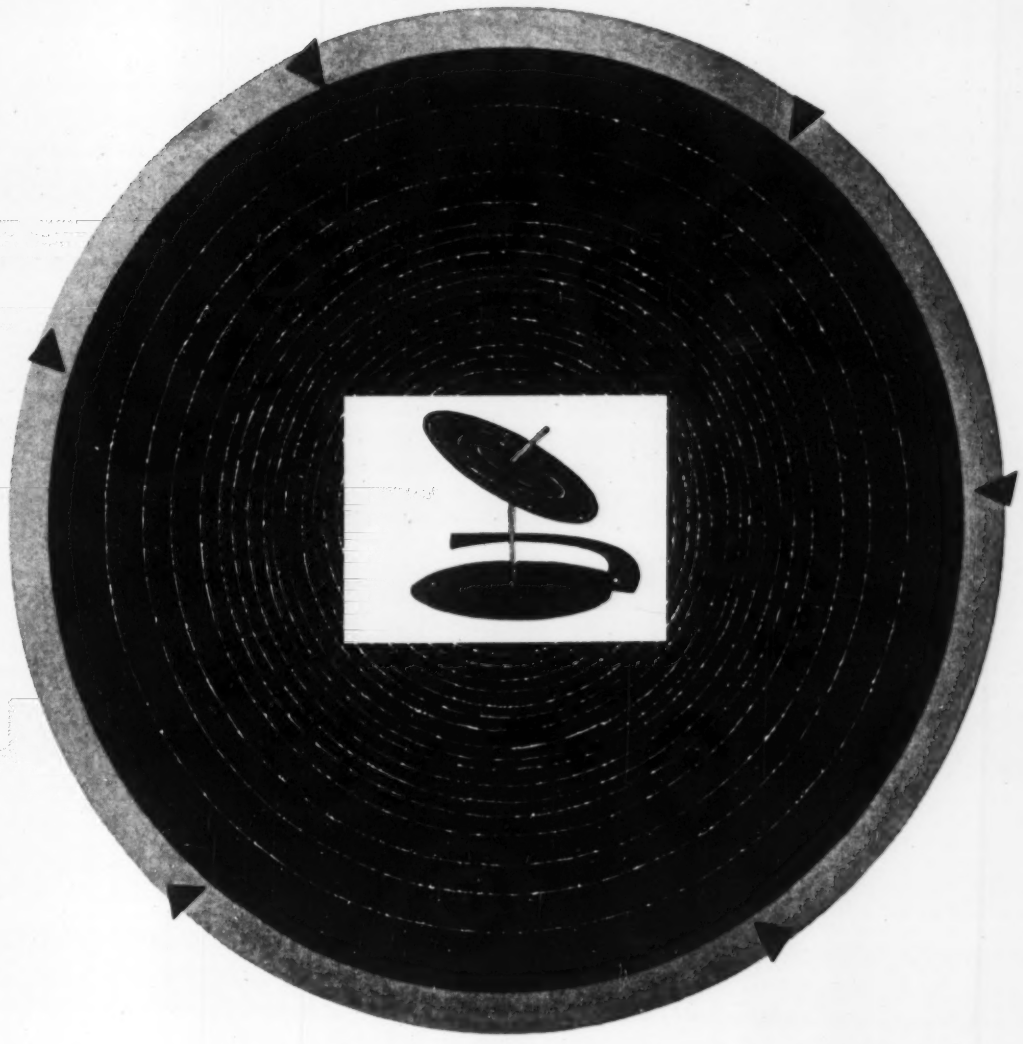
equalling 0.0005 in. per foot. Adjusting screws have 64 threads per inch. Auxiliary level shows lateral position. Length 15 in.; comes packed in well-finished wooden box with hinged cover.—*The Lufkin Rule Co., Saginaw, Mich.*

For more information circle **256** on inquiry card.

Center Micrometer

New bench type of "Center-Mike" measures center-to-center distances to 0.0005 in. in ten seconds regardless





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Crucible has been one of the largest producers of this type of magnet since the alnico alloys were first developed. And backing up this twenty-year magnet experience are 54 years of *quality* steelmaking. For highest quality alnico magnets and technical help in their application, *call Crucible.*

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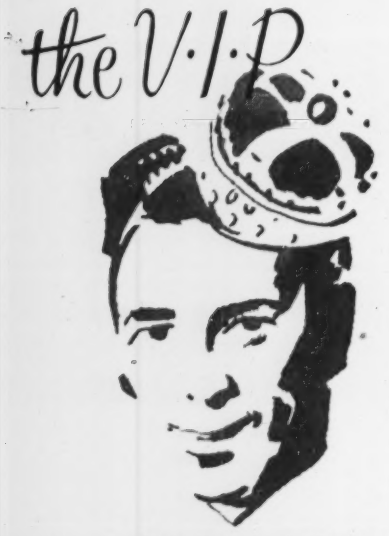
For more information circle **56** on inquiry card.



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Swagelok Tube Fittings have a solid reputation for providing leakproof seals at all tube connections.

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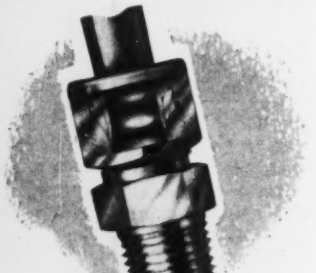

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884 E. 140th Street, CLEVELAND 10, OHIO

Swagelok Tube Fittings

Available in: Brass, Aluminum, Steel, Stainless Steel, Monel

For more information circle **57** on inquiry card.

NEW INSTRUMENTS

of hole sizes—in flat and irregular metal components having center distance ranging from 0.040 to 12.4 in. Virtually foolproof technique: contacts are set against closest points in holes, then against farthest points. Three types, various ranges, each comes in a mahogany case with a center-distance standard check bar.—*Sorenson Center-Mikes, Inc.*, 264 *Kossuth St., Bridgeport, Conn.*

For more information circle **257** on inquiry card.

Dial Indicators

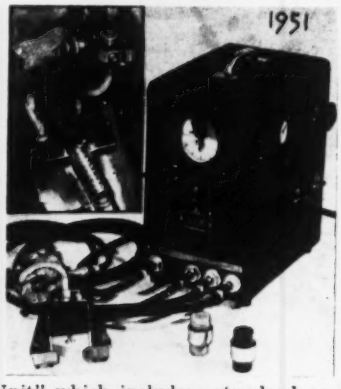
New line of dial indicators combines improved design with features of previous models; offers 140 models,

"Regular" and "Nonshock" types, with balanced or continuous dials, jeweled or plain (inserted bronze) bearings, English or Metric graduations, in all four standard A.G.D. groups plus a complete series of "Long Range" models.—*The L. S. Starrett Co., Athol, Mass.*

For more information circle **258** on inquiry card.

Centerless Grinder Gage

New "Air-O-Limit Centerless Grinder Gage" comprises "Air-O-Limit Snap Gage," "Booster Check Valve," and "Light Signal Control

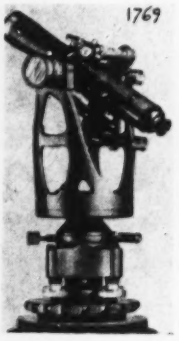


Unit" which includes: standard gaging indicator calibrated to meet requirements, Nullmatic and Kendall regulators, pressure gages, pneumatic relays with electric pressure switches, and red and green limit lights. In illustration, insert shows snap gage and booster check valve mounted on a centerless grinder, gaging through-feed ball bearing outer raceways.—*Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford 1, Conn.*

For more information circle **259** on inquiry card.

Optical Tooling Instruments

New jig transit and optical transit square (made by Brunson Instrument Co.) minimize alignment errors; establish and maintain a vertical plane for setting points in assembly work, for gaging wear in tools and dies, and for general aligning purposes. Procedure in use of jig transit is based on "auto collimation" or "auto reflection" principle. Optical transit square (not illustrated) represents an extension of jig transit application. Its beam-splitter window permits a number of optical squares to be set up on one main line of sight.—*Charles Bruning Co.*, 4700 *Montrose Ave., Chicago* 41, *Ill.*



For more information circle **260** on inquiry card.

Granite Layout Plates

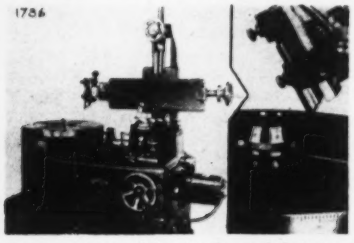
New uniquely-lapped black granite layout plates feature a "layout finish" which prevents seizure of gage blocks and checking fixtures. Continuous bearing surface is interspersed with micronic valleys (grain pattern too small for naked eye). Plates are now lapped to a finish of 3 to 16 microinches rms.—*Collins Microflat Co.*, 2326 *E. 8th Street, Los Angeles* 21, *Calif.*

For more information circle **261** on inquiry card.

MACHINE AUTOMATION

Dividing Machine

New "Atwood Automatic Circular Dividing Machine," for dividing flat, cylindrical and tapered dials for in-

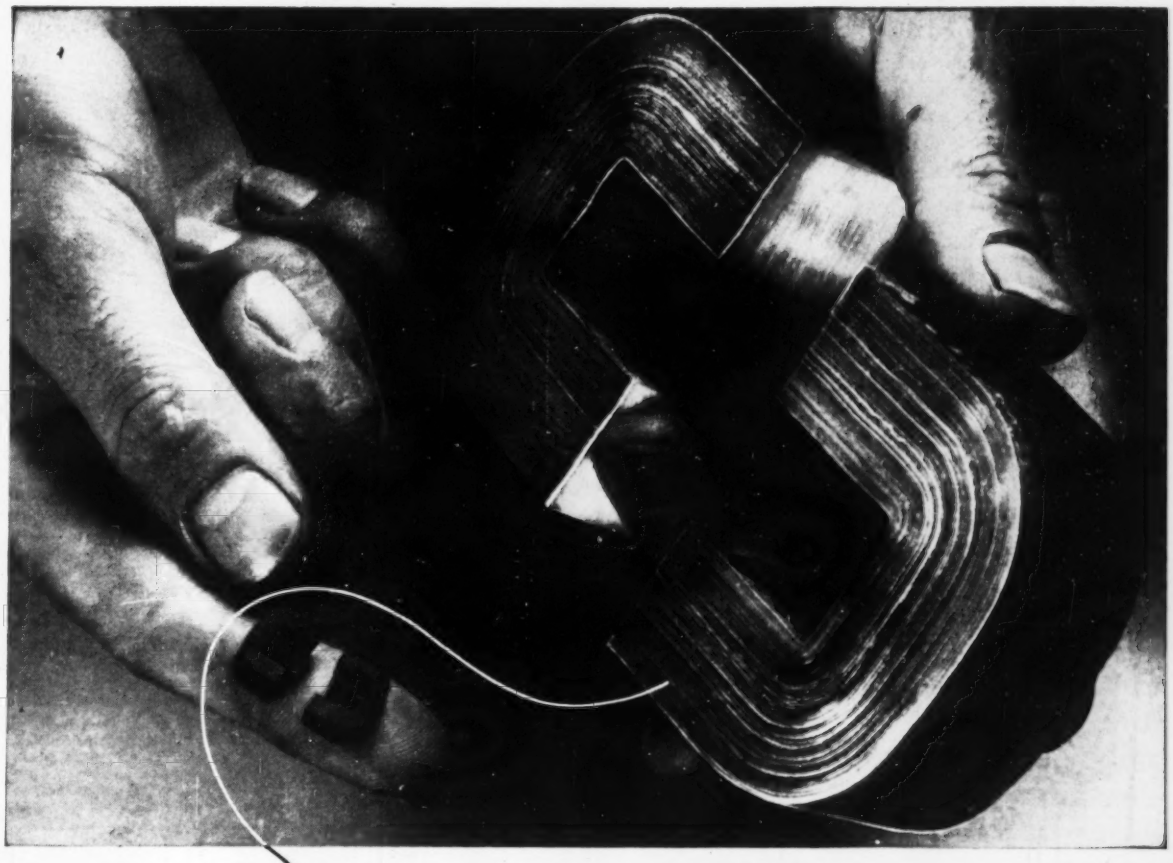


struments, machine tools and fixtures, features: (1) a 20-in. table, (2) accuracy through master cams—not gear trains, (3) automatic cyclic operation, (4) quick resetting of lengths of graduations.—*Engis Equipment Co.*, 431 *S. Dearborn St., Chicago* 5, *Ill.*

For more information circle **262** on inquiry card.

Automatic Machine Tool

New machine tool of "Transfermatic" type has 29 stations: for drilling, chamfering, end-milling counterboring, reaming and tapping operations on sides, ends and top of automatic transmission housings. Capacity, 100 pieces per hour at 100



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...any quantity and any size

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For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

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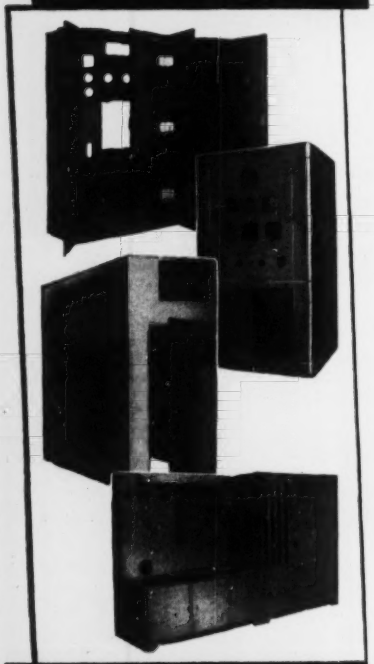
For more information circle **58** on inquiry card.

FOR ACCURATE FABRICATION of CUBICLES, CABINETS, PANEL BOARDS, see LITTLEFORD



Manufacturers of Electrical and Hydraulic Control equipment must have accuracy in the fabrication of Cubicles, Cabinets, Control Boards and Panel Boards. Accuracy comes through experience in knowing how to shear, bend, form and weld plate and sheet metals. Littleford has that experience, plus skilled craftsmen, as industry has been served by Littleford since 1882.

These long years of producing fabricated products reflect in the finished unit. Littleford facilities are modern and afford an unprecedented standard of dependability and quality. If you have a problem involving accurate fabrication remember there is no substitute for experience, and no substitute for Littleford workmanship.

Send blueprints and be assured of quality at low cost.

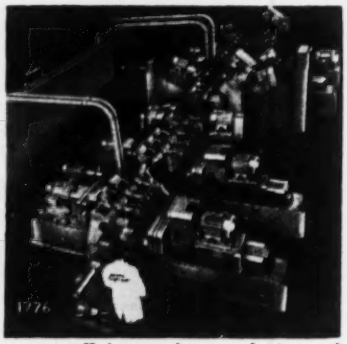
FABRICATORS OF PLATE AND SHEET METAL PRODUCTS FOR INDUSTRY SINCE 1882

LITTLEFORD

LITTLEFORD BROS., INC.
404 E. Pearl St.
Cincinnati 2, Ohio

For more information circle **59** on inquiry card.

NEW INSTRUMENTS



percent efficiency. Among features is use of pre-set tools and maker's "Machine Control Unit" with "Toolometers" for programming tool changes. —*The Cross Co., Detroit 7, Mich.*

For more information circle **263** on inquiry card.

Turret Indicator Stop

New "Sure-Stop" turret indicator stop aids in duplication of machined parts requiring close tolerances; maintains length tolerances; minimizes possibility of operator error brought about by elements of pressure and feel by indicating correct pressure. Unit is mounted on lathe carriage and stop mounts on lathe bed. Five quickly-adjustable stops; added fine adjustments made on drill rods for close tolerances. Dial indicator range 0.150 in., 0.001-in. divisions; center dial reads accumulated rotations of arrow in thousandths; adjustable tolerance limits. Primarily designed for lathes, unit can be quickly adapted to other machine tools.—*D-S-C Machine Co., 27 Bertel Rd., Mount Vernon, N. Y.*

For more information circle **264** on inquiry card.

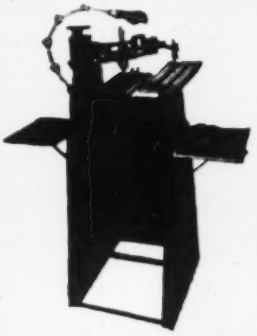
Abrasion-type Cutting and Shaping Tool

New "Model C Airbrasive Unit" can be used for precision cutting, drilling, etching and light deburring on hard brittle materials. Cutting action is almost non-heating, is performed by a fine stream of gas-propelled abrasive particles, traveling at near-supersonic speeds, directed at work through a small orifice nozzle. Selection of nozzles is available. With smallest nozzle, lines as fine as 0.008 in. can be cut.—*S. S. White Industrial Div., 10 East 40th St., New York 16, N. Y.*

For more information circle **265** on inquiry card.

Engraving Machine

New "Model UE-3 Preis-Panto" engraving machine has a fabricated floor stand, a new hand-wheel-screw work-table adjustment and other new features; is claimed to eliminate interference that occurs when two or more bench-type engravers are mounted on a common bench. Weight complete 170 lbs. Prompt delivery.—*H. P. Preis Engraving Machine Co., 50 Industrial Branch, Hillside, N. J.*



For more information circle **266** on inquiry card.

Polishing Stand

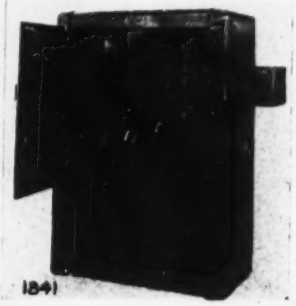
New portable polishing stand for optical polishing paper is designed to eliminate difficulties experienced when attaching and holding flat any optical polishing paper on a metal plate. It also eliminates time consumed in replacing paper after use. It permits a complete 50-yd. roll of 12-in. wide optical paper to be made available for immediate use.—*Crane Packing Co., 1800 Belle Plaine Ave., Chicago, Ill.*

For more information circle **267** on inquiry card.

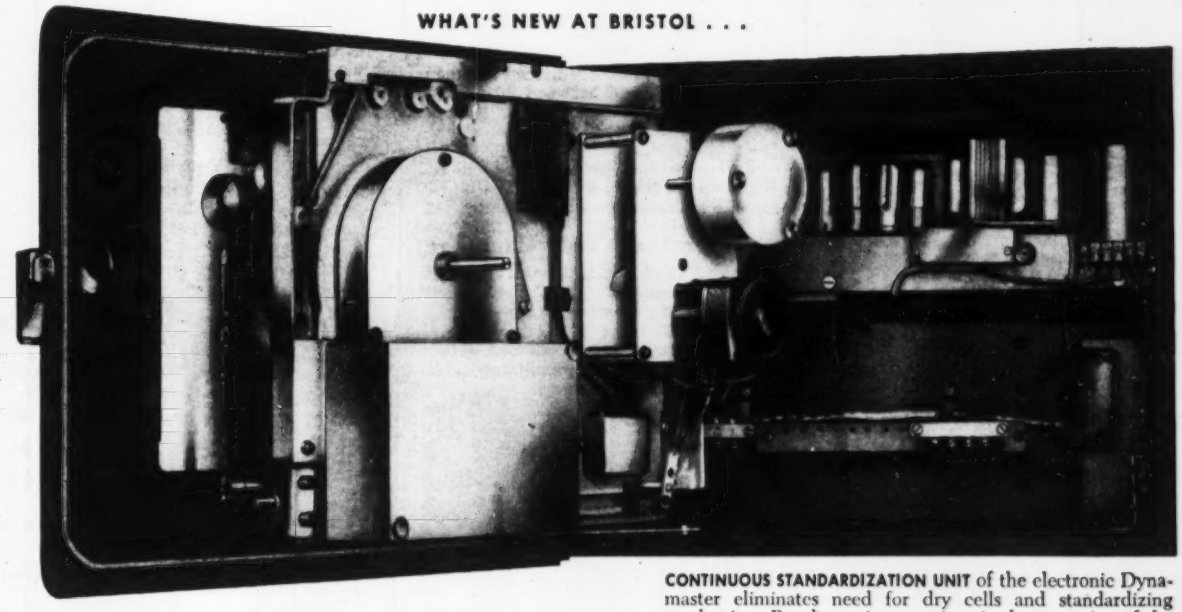
TESTING

Humidity and Temperature Test Cabinet

New "Weatherlab" humidity-temperature test cabinet for use in above-freezing range is available in standard 20 and 30 cu. ft. sizes for



WHAT'S NEW AT BRISTOL . . .



CONTINUOUS STANDARDIZATION UNIT of the electronic Dynamaster eliminates need for dry cells and standardizing mechanism. Result: no interruptions in the operation of the potentiometer for standardization; no batteries to replace.

No time out for standardization here

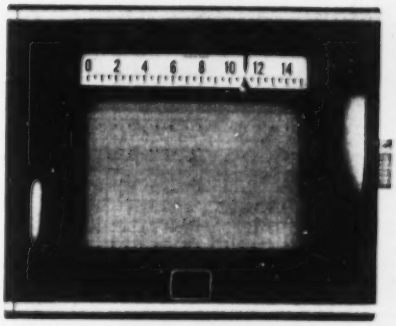
Bristol Dynamaster potentiometer pyrometers give you No-Batt continuous standardization

• You don't have to put up with interrupted performance from old-fashioned potentiometer pyrometers any longer!

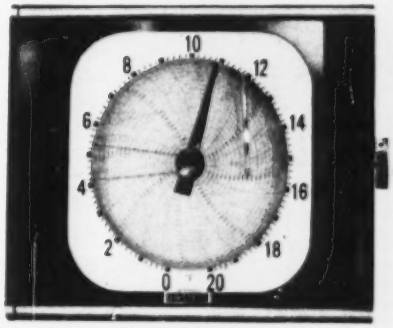
When you use a Bristol thermocouple or radiation-type Dynamaster, you get a *continuous* record or control of temperatures up to 4000°F in any type of fuel-fired or electric furnace or heating equipment. Thanks to the exclusive No-Batt continuous standardization which eliminates the need for dry cells in these electronic instruments, Bristol has been able to do away with interruptions formerly required for periodic standardization.

Bristol electronic Dynamasters are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers with all types of control actions. Two-pen and program control.

For the complete story on the modern human-engineered Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



BRISTOL DYNAMASTER CONTROLLERS in either the strip-chart model (shown above) or round-chart model, may be electrically or air operated. 2 position, 3 position, proportional, manual with automatic reset, or proportional input controls. On - off, proportional or reset air controls.



BRISTOL DYNAMASTER RECORDERS come in easy-to-read round-chart (shown here) or strip-chart models. Single record, multiple record or continuous 2 record designs are available. Bristol also supplies all types of time-temperature program controllers.

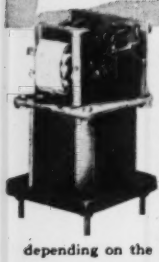
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

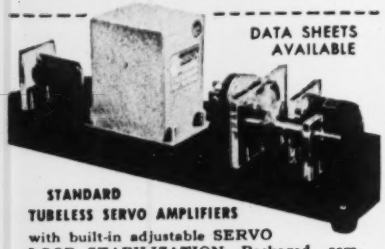
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **60** on inquiry card.

STANDARD PACKAGED PUSH-PULL MAGNETIC AMPLIFIERS by MA



MAGNETIC AMPLIFIERS—These high gain, high performance Magnetic Amplifiers are especially suitable to drive two phase induction servo motors requiring from 0.1 watt to 20 watts per phase on either 400 cps or 60 cps powerlines. The output power is either in phase or 180 out of phase with the powerline depending on the D.C. input signal polarity.



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STANDARD TUBELESS SERVO AMPLIFIERS with built-in adjustable SERVO LOOP STABILIZATION. Packaged, completely self-contained, magnetic servo amplifiers for position servo systems where either A.C. or D.C. error signals are available. Designed for instrument type and power type servo systems to work with synchro control transformers or potentiometers and two phase induction servo motors.

TRANSISTOR CURVE TRACER

USES—Designing transistor circuits — comparing, matching and selecting—detecting anomalies—studying effects of temperature, age, normal usage, over-loading—detecting failures and cause.

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FEATURES

Tests NPN, PNP, Junction, Point Contact Transistors—flexible to accommodate new types. Dynamically plots entire family of curves simultaneously on standard laboratory DC oscilloscope. Function switch selects: output or transfer curve in grounded base or grounded emitter connection. Calibrating axis generated internally as integral part of display are always in correct quadrant.

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632 TINTON AVE., NEW YORK 55, N. Y.

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For more information circle **61** on inquiry card.

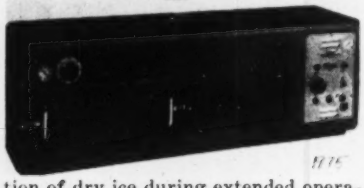
NEW INSTRUMENTS

simulation of most conditions between 35 and 200 F. and between 20 and 95 percent r.h.; is suitable for testing products for conformance to above-freezing JAN, MIL, and other specs. —*Refrigeration Systems, Inc.*, 646 *W. Washington Blvd., Chicago 6, Ill.*

For more information circle **268** on inquiry card.

Temperature Test Chamber

New "TC-2 Temperature Test Chamber," superseding "TC-1," has extended range permitting tests from −65 F. to 350 F.; Weston industrial thermometer mounted on front panel; loading port at top permitting addi-



tion of dry ice during extended operation at low temperature. Working space 7-in. high x 15-in. wide x 7½-in. deep. Test load is carried in a removable tray provided with fifteen ⅜-in. diam. openings for connections to objects under test.—*Statham Development Corp.*, 12411 *W. Olympic Blvd., Los Angeles* 64, *Calif.*

For more information circle **269** on inquiry card.

Portable Tension Tester

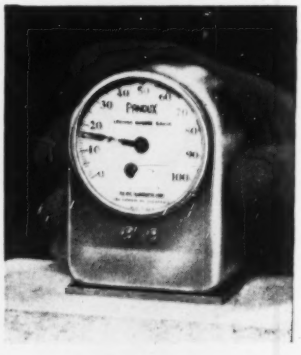
New "Model 948" portable tension tester measures (1) variable load at a fixed distance or (2) variable distance at a fixed load; is readily

adapted to special uses; can be made to individual specifications. It has been used as a field service tool (to test carbureter-valve springs and business-machine springs.) Lineal range ¼ in. to 6 in.; tension from ¼ lb. to 1¼ lbs.—*John Chatillon & Sons*, 85-93 *Cliff St., New York* 38, *N. Y.*

For more information circle **270** on inquiry card.

Foam-rubber Softness Tester

New "Model 302S Pandux Foam (Sponge) Rubber Tester" is a hand tester for measuring hardness or resiliency of foam and sponge rubbers, as well as of other soft elastomers. A measurement is made by pressing it against material so that base is flush



with material surface. This permits indentor to give a direct reading on scale.—*Pacific Transducer Corp.* 11921 *W. Pico Blvd., Los Angeles* 64, *Calif.*

For more information circle **271** on inquiry card.

Temperature-cycle Tester

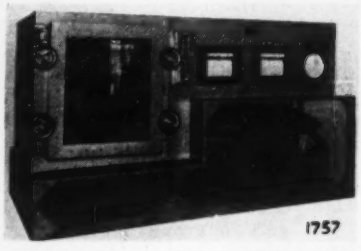
New "St-120-3" testing chamber will automatically cycle test parts through alternate hot and cold tem-

eratures, up to 200 F. and down to −120 F. High and low holding times adjustable between 0 and 120 minutes. Other equipment includes a 24-hour chart recording thermometer, and a 2-in. porthole through which may be run test leads, etc.—*Cincinnati Sub-Zero Products Co.*, 3932 *Reading Rd., Cincinnati* 29, *Ohio.*

For more information circle **272** on inquiry card.

Environment Simulator

New environment-simulation chamber provides up to 7.5 psi. positive pressure in addition to simulating tem-

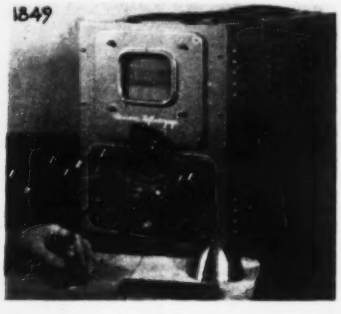


peratures from 185 F. to −100 F., altitudes to 60,000 ft. and relative humidity from 20 to 100 percent.—*American Research Corp.*, 11 *Brook St., Bristol, Conn.*

For more information circle **273** on inquiry card.

Ultrasonic Inspector

New model of "Reflectogage" measures thickness of steel sheet where only one surface is available, checks continuity of bonds, tests raw stock



MALLORY

Mercury Batteries Deliver

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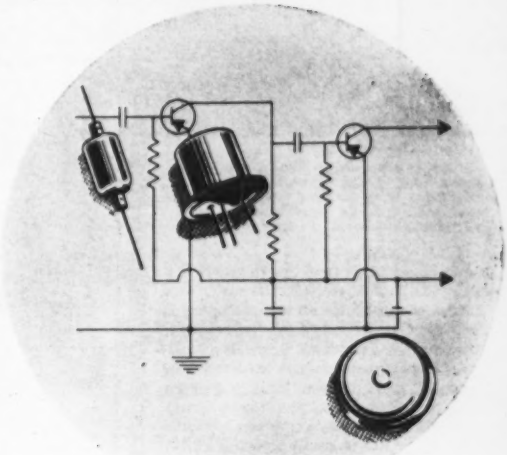
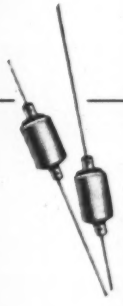
...Constant Voltage



.....a necessity for the best performance of transistor circuits



These tiny, Mallory-developed Silverlytic Capacitors are also perfectly suited to the specialized needs of transistor and other low voltage circuits. Write today for information.

Because they are designed especially for transistor circuits, Mallory Mercury Batteries offer the designer of transistor equipment many advantages.

Constant current—constant voltage. Operating either intermittently or continuously, Mallory Batteries provide energy uniformly and dependably. They require no rest periods in order to maintain operating efficiency.

Long shelf life. Even after many months—or even years—of storage, Mallory Batteries maintain their constant output characteristics and give long dependable performance.

For temperature extremes from −65° F to +250° F, Mallory Mercury Batteries have proven their ability to maintain constant potential characteristics.

Highly resistant to humidity and corrosion. Double nickel-plated steel jackets give extra protection to equipment that must operate in corrosive fumes, salt spray or high humidity.

Absolute vacuum or 5000 psi will not affect the operation of Mallory Batteries.

High ratio of energy to size and weight permits miniaturization of electronic equipment.

Leakproof and dimensionally stable. Mallory Batteries will not leak corrosive acids and can be safely used in close fitting receptacles.

If you are designing equipment around transistor circuits, be sure and get complete information on Mallory Mercury Batteries. Our engineers will be glad to work with you in selecting a power supply that will meet your requirements. Technical Bulletin 1-6 will be mailed on request.

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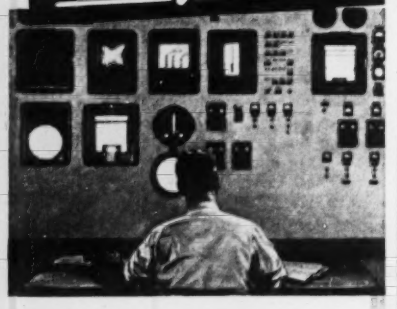
For more information circle **62** on inquiry card.

DIAMOND
"UTILISCOPE"
(WIRED TELEVISION)
IMPROVES
Centralized Control



Operator in central control room of large power station "SEES WHERE HE CAN'T LOOK". Here he watches flame conditions in boiler furnace, stack smoke discharge, and water level in boiler on "Utiliscope" screens of control panel.

Centralized control is much more effective if it brings a SENSE OF REALISM into the control room . . . if the operator can actually see what is going on outside his range of vision instead of depending upon indirect interpretations of operating conditions. The electric power industry has accepted the "Utiliscope" as an important factor in achieving better centralized control (as shown above).

The "Utiliscope" has many other uses in industry where its low cost is quickly amortized by improved operation, greater safety or savings in labor. It is surprisingly simple and requires no special skill for installation and operation. Stability and reliability are exceptional. For additional information use coupon below.

"UTILISCOPE" RECEIVER "UTILISCOPE" CAMERA

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Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

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OFFICES IN 39 PRINCIPAL CITIES
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For more information circle **63** on inquiry card.

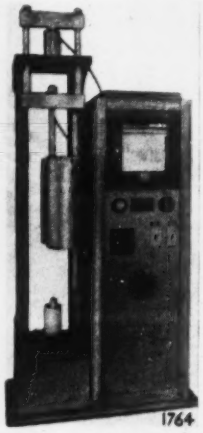
NEW INSTRUMENTS

for laminar defects. Using high accelerating voltages and slow sweep speed, it gives visual indications of steel thickness from 0.014 to 0.400 in. on a flat-face, no-parallax cathode-ray tube with directly-adjacent calibration tape. Tape is cranked into position for any one of six available testing ranges. Tolerance markers are adjustable in both width and position. —*Sperry Products, Inc., Danbury, Conn.*

For more information circle **274** on inquiry card.

Creep-testing Machine

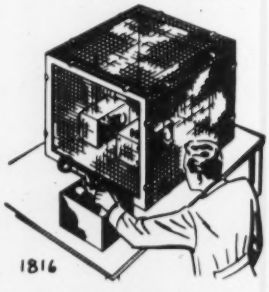
New automatic high-temperature relaxation creep testing machine of 10,000-lb. capacity utilizes an "SR-4 Load Cell" as an electrical pickup for load measurement; offers advantage of additional lower load ranges (5000 and 2500 lbs.) with a single pickup. Accuracy is within 1 percent of reading or 0.25 percent of full scale, whichever is greater. Standard recorder has a 150-ft.-long 10-in. strip chart with 100 divisions for full-scale readings; chart speed ¼ in. per hour. Loading mechanism is a motor-driven screw jack; loading stroke 2⅛ in. Elongation of the specimen is held constant by an extensometer with electrical follow-up contact. Contacts operate unloading movement for strains of approx. 2 microinches per inch.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*



For more information circle **275** on inquiry card.

Portable Screen Room

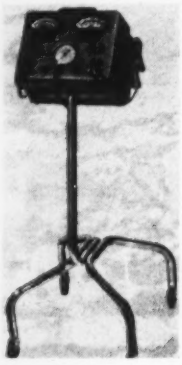
New "Portascreen," said to be "entirely new to the industry," is a prefabricated fully-assembled 35½-in.-cubical screen room. (Other sizes available.) True double shielded screening with attenuation of over 100 db from 5 Mc. to 10,000 Mc., equalling that of maker's larger screen rooms. Shipped sections can be assembled in 5 minutes.—*Erik A. Lindgren & Associates, 4515 N. Ravenswood Ave., Chicago 40, Ill.*



For more information circle **276** on inquiry card.

Auto Engine Tester

New "Model TUT Tune-Up Tester" speeds up and improves engine tune-ups; makes seven over-all tests: (1) cranking voltage; (2) dwell tests for distributor trouble; (3) ignition timing; (4) secondary efficiency to show poor distributor cap and rotor connections, faulty wires and fouled spark plugs; (5) ignition test; (6) engine vacuum; (7) operating voltage. Purchase price (less than two hundred dollars), includes instruction at time delivery is made.—*Sun Electric Corp., Harlem and Avondale Aves., Chicago 31, Ill.*



For more information circle **277** on inquiry card.

Sound Level Meter

New "IT-140M Sound Level Meter" is a low-cost light-weight pocket-size instrument for checking frequency response and dynamic range of high-fidelity sound systems; checking individual loudspeakers, record-players, recorders; and complete checks including response of room or auditorium.—*Industrial Television, Inc., 369 Lexington Ave., Clifton, N. J.*

For more information circle **278** on inquiry card.

Inspection Lamp

New "Rectangular Illuminated Inspection Lamp" has 6½ x 2½-in. plano-convex lens, 6-in. focal length, rack-and-pinion focusing, two 12-watt fluorescents.—*Esco Products, 1428 Willow Ave., Hoboken, N. J.*

For more information circle **279** on inquiry card.

Glide-slope Tester

New "Type F-12 Filter Assembly" is designed to be used with any signal generator which provides 90/150-cps. modulation for airborne VHF glide slope or localizer receiver testing, to

By all indications **YOUR BEST BUY**

CLIMATE-PROOF CASE. Rain tight . . . snow tight . . . dust tight . . . sand tight . . . frost tight. The American Bi-Metal Thermometer can withstand submersion, hot blasts, dust, hot gases, extreme temperature changes and long exposure to the elements.

MAXIMUM RESPONSE — MINIMUM FLUTTER. Highly sensitive dampening fluid on bi-metal coil assures fastest response to temperature changes and greatest resistance to pointer flutter and destructive vibration.

ALL WELDED STEM CONSTRUCTION. Processing media cannot seep into case. Stem is stainless steel — corrosion-resistant — contributes to longer thermometer life.

Refineries, chemical and other processing plants find the American Bi-Metal Dial Thermometer "tops" for on-the-spot temperature readings.

Accurate

AMERICAN BI-METAL DIAL THERMOMETERS

Accuracy is guaranteed within 1% of the scale range. Application is simple and fast. Adequate clearance at back of case permits easy use of wrench during installation. Get complete information about these precision-built, long-life thermometers. Write for Bulletin 144.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. Take advantage of the broad experience of his organization and his ability to meet your most exacting requirements quickly from local stocks.

SPECIFICATIONS

Temperature Ranges: From minus 60° to 1000° F.

Dial Sizes: 3½" and 5". Graduations over full 270° arc.

Case: Aluminum alloy with smooth, black enamel instrument finish.

Bezel: Screwed to case.

Front: Heavy plate glass set in channeled gasket seals the case.

Pointers: Adjustable type attached with set screw; easy to get at for setting.

Connection: Fixed, ½" N.P.T.

Separable Sockets: Available for use in closed systems or where the measured medium is corrosive to the stainless steel stem. Fit over all standard stem lengths except 2½".

1850 AMERICAN U S A

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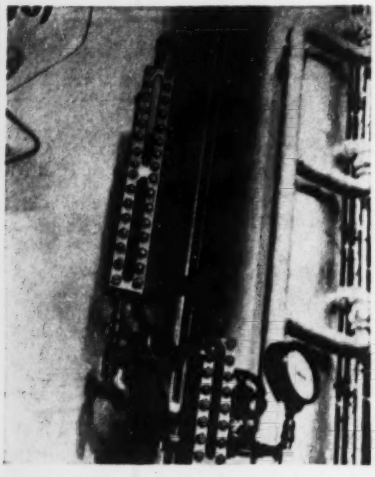
For more information circle **64** on inquiry card.

BLACK WHITE

VISIBILITY



JERGUSON Series #5 Reflex Gages Give you up to 19¼" of Clear Visibility

THE sharp black-white contrast of the liquid level against the empty space above, in Jerguson Series #5 Reflex Gages, makes possible highly accurate liquid level readings even where lighting is poor.

To give you extra long service, the gages are corrosion resistant; and the glasses are specially treated with Jerguson Anti-Fouling Compound to give clearest visibility over a long period.

Series #5 Low Pressure Reflex Gages are available in sections to give you any desired total gage length. Materials used are selected to conform to or exceed the rigid requirements of A.I.S.I., A.S.T.M., and/or A.P.I.-A.S.M.E. specifications.

You can depend on Jerguson Gages. Write today for full information on Series #5 Gages, or for help on any gage problem.

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For more information circle **65** on inquiry card.

NEW INSTRUMENTS

permit checking accuracy of modulation levels provided by generator. Two pairs of matched 90- and 150-cps. filters, for self-checking, provide increased safety factor of calibration precision.—*Aircraft Radio Corp., Boonton, N. J.*

For more information circle **280** on inquiry card.

Custom-made Testers

New "Power Test-Sets" are available to customer's requirements. Cut shows "Model 78-S," which adds a frequency meter to regular power

values indicated as volts, amperes, kilowatts and vars, polyphase, with phase rotation indicator included.—*Niagara Electrical Instrument Co., 559 Ellicott St., Buffalo 3, N. Y.*

For more information circle **281** on inquiry card.

Resistance Tester

New "Model 601 High Resistance Bridge" covers range from 0.1 to 100 megohms; accuracy better than 0.25 percent. Bridge unbalance voltage is amplified and fed to a null indicating microammeter. Circuit is such that indicator cannot be damaged by severe unbalance. Bridge can be used for production testing of resistors, and for general-purpose resistance measurements.—*Shasta Div., Beckmann Instruments, Inc., P.O. Box 296, Sta. A, Richmond, Calif.*

For more information circle **282** on inquiry card.

Linearity Checker

New "Lin-A-Chek" determines linearity of indicating instruments such as voltmeters, milliammeters, galvanometers and recorders; of amplifiers, and of complete instrumentation channels; checks preciseness of scale selector on VTVMs and other multirange instruments of constant input impedance; provides a sequence of ten precisely equal increments of a-c. or d-c. voltages or currents.—*Micrometrical Development Corp., 2821 S. State St., Ann Arbor, Mich.*

For more information circle **283** on inquiry card.

Ohmmeter

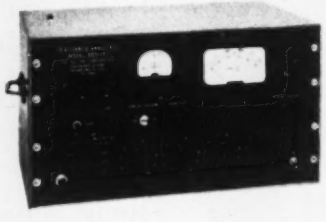
New "Model C-6 Resistance Meter" adds a new feature to maker's previously-available ohmmeters: it is now possible to pre-set an acceptable

value of capacitor leakage resistance, then test capacitors by using instrument as "go-no-go" gage.—*Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston 19, Tex.*

For more information circle **284** on inquiry card.

Resistance Analyzer

New Resistance Analyzer measures voltage coefficient of resistances from 1,000 ohms to 111 megohms to within 0.1 percent. Voltage coefficient of any resistor up to 1.5 watts can be



determined to as low as 0.0002 percent per volt. Voltage across measured resistance is continuously variable in two ranges from 0 to 500 volts.—*The Kuljian Corp., 1200 N. Broad St., Philadelphia, Pa.*

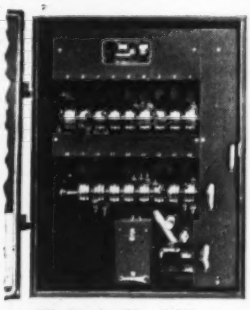
For more information circle **285** on inquiry card.

Voltage Coefficient Tester

New "Voltage Coefficient Test Set," first commercially-available instrument of its kind, provides a rapid and reliable measurement of voltage coefficient for composition resistors;

Why Automatic Sequencing of Batch Operations AVE DOLLAR$ . . .

. . . because the Taylor FLEX-O-TIMER® Time Cycle Controller "does its own thinking"—takes care of as many as 36 operations automatically, thus saving operator man hours!



The Taylor Flex-O-Timer Time Cycle Controller

THIS dividend-paying instrument is the Taylor FLEX-O-TIMER Time Cycle Controller. It provides precise, automatic timing of the sequence and duration of up to 36 processing operations involving temperature, pressure, mechanical motion, electrical energy or combinations. There are hundreds of applications throughout industry where this versatile controller can insure greater uniformity of processing, save operator effort -- both physical and mental—and save you money. If you say "yes" to any of these questions it will pay you to call in your Taylor Field Engineer now.

Q. Do you have batch processes requiring personnel to perform multiple operations in sequence with complete reliability?

A. The Taylor FLEX-O-TIMER Controller enables you to coordinate batch processes to meet the requirements of a continuous process. You don't have to rely on people to turn the valves or perform other operations at the right time; e.g., the regeneration of a contaminated catalyst bed in a continuous process. The FLEX-O-TIMER Controller will:—stop the process; clean out process fluids; backwash the bed—or burn out the impurities; put the unit back on stream. All this automatically and in accordance with the best practices.

Q. Are you faced with reprocessing and consequent costly waste if certain manual operations do not take place at the right time, in the right sequence and for the correct duration?

A. You eliminate the possibility of human error with this robot brain in control. You can depend on the FLEX-O-TIMER Controller to turn the valve, pull the switch or perform other operations—automatically; e.g., the molding of plastics or vulcanizing of golf balls.

Q. Can customer dissatisfaction ever be traced to variations in product quality due to processing irregularities?

A. Once you've developed the optimum time, temperature, pressure and other variables for a process you can be sure of repeating that process *exactly*, time after time; e.g., backwashing of filter beds in a continuous process. Result: You are assured of a uniformly high quality product—the secret of repeat business.

Q. Wouldn't you consider it a good investment if a completely automatic sequencing control system applied to your batch processes paid off in a year or less?

A. Many chemical plants have increased their profits by revamping their batch processes in this way, using the Taylor FLEX-O-TIMER Controller as the key instrument; e.g., the operation of hydraulic presses in removing excess chemical from fibrous materials; plastic press operation; dry ice molding; the lamination of plywoods; tire molding; the opening and closing of dump valves in paper pulp bleach cells; the batch hydrogenation of edible oils and fats.

Q. Why is this system so successful?

A. Because Taylor Instrument Companies have the necessary experience and know-how to apply instrumentation of this kind to the best advantage in many diversified industries. Taylor Engineers have acquired this skill through many years of working in the field with instrument men and engineers. Their knowledge is at your disposal. Why not write today! Also ask for **Bulletin 98154.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

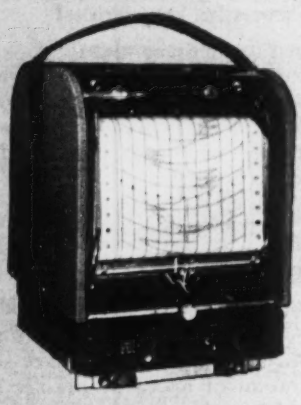
Taylor Instruments
MEAN ACCURACY FIRST

For more information circle **66** on inquiry card.

HARD WORK WANTED!

magnetic fluid clutch recording milliammeter

If *you* must make SENSITIVE RECORDINGS under ADVERSE CONDITIONS, the Texas Instruments field-proven Dual Recording Milliammeter was designed with you in mind. It is a durable, ink-writing, accurate recorder with two independent channels and four selective chart speeds . . . all in a 15¼ lb, portable instrument.



MAGNETIC FLUID CLUTCH meter movements make possible a sensitivity of 0.45 inch per 100 microamps combined with adherence to rigid military aircraft requirements for shock, vibration, explosion, and humidity resistance. High resultant torque permits the startling reduction in recorder size and weight and creates a new degree of independence from shock, vibration and pen drag.

write today for bulletin DL-C 4001

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVE. DALLAS 9, TEXAS

For more information circle **67** on inquiry card.

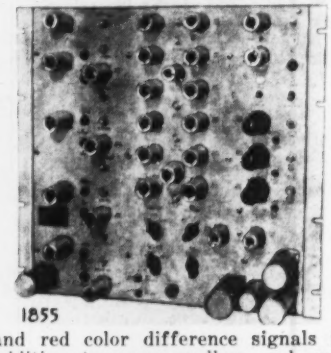
NEW INSTRUMENTS

also for study of resistor materials and geometry, contact behavior, and semiconductor phenomena. It can be used for inspection and quality control. It operates on principle that the non-ohmic nature of a material or resistor (i.e. voltage coefficient) gives rise to current harmonics when an alternating voltage is applied. Temperature nonlinearities are thereby separated from voltage nonlinearities; component can be tested up to rated power-dissipation conditions; harmonics can be accurately interpreted in terms of material's voltage coefficient.—*Brunswick Instruments, P. O. Box 813, New Brunswick, N. J.*

For more information circle **286** on inquiry card.

Color Bar Generator

New "Model 509-DR Color Bar Generator," for TV test and alignment, provides *I, Q, R-Y* signals representing wide-band, narrow-band,



1855

and red color difference signals in addition to green, yellow, red, magenta, blue, cyan, black and white standard color bars; also a dot pattern which may be superposed on any of these.—*Telechrome Mfg. Corp., 88 Merrick Rd, Amityville, L. I., N. Y.*

For more information circle **287** on inquiry card.

Megohmmeter

New "Type L Megohm Meter," for high-speed testing of windings, cables, capacitors, etc., for insulation leakage in accordance with ASTM D-257-52T,

features constant voltage and built-in voltmeter; large reciprocal scale calibrated directly in megohms. Three models of varying ranges and test voltages.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **288** on inquiry card.

Test Clip Insulators

New vinylite insulators for test clips are offered in two new coding colors—Electric Blue and Canary Yellow—in addition to red and black, for

identification of different test leads, for 3-phase circuit test work, etc. Blue and yellow are available for seven clip sizes.—*Mueller Electric Co., 1566B East 31st St., Cleveland 14, Ohio.*

For more information circle **289** on inquiry card.

Color-signal Synthesizer

New "Model 636-B Chromalyzer" is said to be "a complete color TV station in a space 8x8x15 in."; is designed for serviceman faced with problem of checking and aligning home color receivers; provides all standard color signals he needs.—*Telechrome, Inc., 632 Merrick Road, Amityville, L. I., N. Y.*

For more information circle **290** on inquiry card.

ELECTRICAL INSTRUMENTS

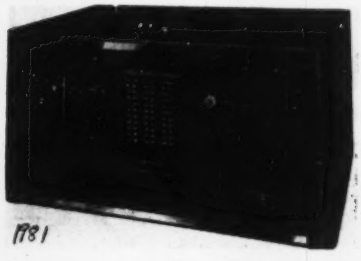
Expanded-scale Voltmeter

New "Model 101" a-c. voltmeter features both scale expansion and means of recording over 100-to-500-volt range. It covers voltage range in thirty-nine 10-volt steps, full-scale. True rms. readings are obtained with accuracies better than 0.25 percent of input voltage. Frequency response is uniform between 50 and 2000 cps. Built-in recorder connections, for continuous recording of line voltage fluctuations with a 1-ma. d-c. recorder, simplify problems of voltage regulation or stabilization in any a-c. system.—*Arga Div., Beckman Instruments, Inc., 220 Pasadena Ave., South Pasadena, Calif.*

For more information circle **291** on inquiry card.

Digital-indicating Volt-ohm-milliammeter

New "Digitester 48A" is a quantizing volt-ohm-milliammeter with accuracy of 0.1 percent and 0.8 second response speed. Readout is in digits. Ranges: up to 10 megohms in seven ranges, 1000 volts in six ranges, 1



1781

ampere in six ranges. Maximum accuracies (lowest scales) are 0.01 ohm; 0.00001 volt; 0.1 microampere. No accessories or external references necessary.—*Telecomputing Corp., Santa Anita Ave., Burbank, Calif.*

For more information circle **292** on inquiry card.

Frequency Standard

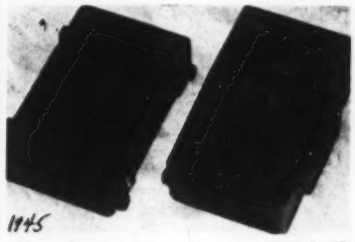
New "Model E-19 Secondary Frequency Standard" provides sinoidal frequencies with accuracy of 0.001 percent; powered from 115 v.ac.,

50/60 cps.; contains internal voltage regulation. Output frequencies of 10,000, 1000 and 100 cps. are derived from low-temperature-coefficient crystal oscillator. Relay rack mounting on request. Models also available with additional output frequencies and other features.—*El Mec Laboratories, Inc., 730 Boulevard, Kenilworth, N. J.*

For more information circle **293** on inquiry card.

Volt-ohm-microammeter

New "PL 1004 Multimeter," made for the Military as "TS352B/U," is now available for commercial and industrial use. This is the identical wa-

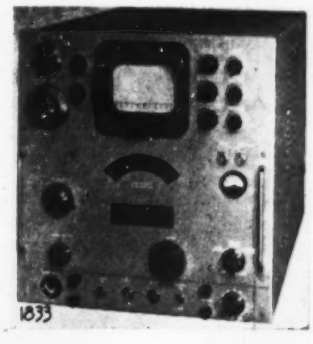


terproof volt-ohm microammeter built to MIL-M-4269 (USAF) and used for testing elements of electronic and electrical circuits and to check existing circuits, both a.c. and d.c.—*Phaostron Co., 151 Pasadena Ave., So. Pasadena, Calif.*

For more information circle **294** on inquiry card.

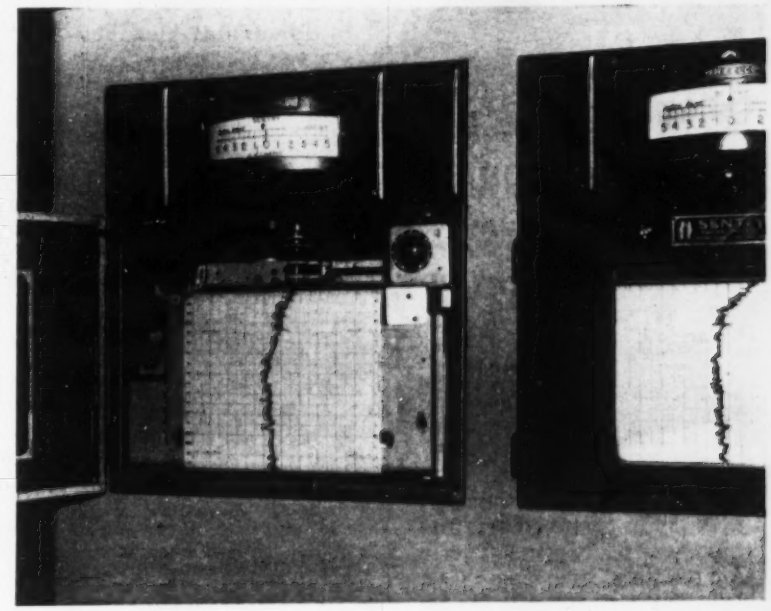
Spectrum Analyzer

New "Model TSA Portable All Band Spectrum Analyzer" covers range of 10 to 22,000 Mc. with three interchangeable RF heads. Single-dial direct-reading RF tuning control for quick selection of any frequency spec-



BARBER COLMAN

Wheelco Recorder-Controllers

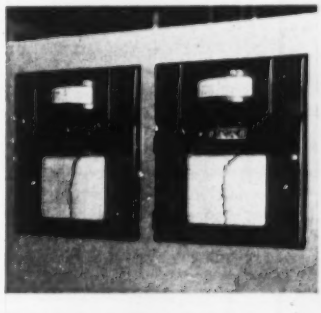


Monitor and record flue gas optical density at AMERICAN SUGAR REFINING CO.

Changes in smoke density too fine to see with a naked eye are indicated and recorded on Capacilog Recorder-Controllers at American Sugar Refining Co., Brooklyn, New York, where Domino Sugar is produced. Versatile Capacilogs provide for excess smoke and air indication and signaling for a variety of smoke abatement jobs. Their unique simplicity assures maintenance-free, dependable operation. Use them for precise measurement, indication, control, and permanent record of temperatures, speed, static strain loads, a-c/d-c voltage and amperage. Read about Capacilog accuracy and simplicity in Wheelco Bulletin C2-2.

Stop smoke, save fuel!

Sentry smoke density systems, manufactured by L. V. Edwards, Rockville Center, New York, cut fuel losses due to excess air or smoke. Light beam across stack breeching falls on Photronic cell to which Capacilog meter is connected. Capacilog controls spotlight, signals, etc., and records changes in smoke density.



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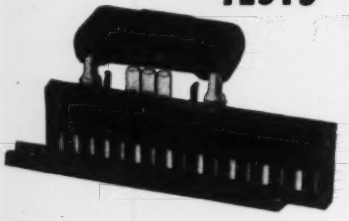
Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **68** on inquiry card.

"couldn't do without my

TAYLOR COMPARATOR

for pH, CHLORINE TESTS"



That's what chemists and engineers say in plants all over the country . . . because Taylor Comparators give you fast, easy determinations of pH, chlorine, phosphate, as well as complete water analysis. And you can make these determinations anywhere in the plant! No need to carry solution samples back to the lab since your Taylor set is lightweight, small, and no trouble at all to carry with you.

ACCURATE

There's no chance of mechanical inaccuracy because all Taylor Liquid Color Standards carry an unlimited guarantee against fading!

EASY TO USE

Taylor Comparators use the familiar colorimetric method of comparison, but without the need for fragile, single Nessler tubes. All color standards for a single determination are housed in a sturdy plastic slide. Many different slides may be used on the same base.

GET THE FULL STORY from your lab supply dealer or write for free book, "Modern pH and Chlorine Control". Gives theory and application of pH and Chlorine control, illustrates and describes full line of Taylor Comparators.

W. A. TAYLOR AND CO.
416 RODGERS FORGE RD • BALTIMORE, MD

For more information circle **69** on inquiry card.

NEW INSTRUMENTS

trum. Swept IF yields constant dispersion characteristics completely independent of frequency setting.—*Polarad Electronics Corp.*, 100 *Metropolitan Ave., Brooklyn* 11, *N. Y.*

For more information circle **295** on inquiry card.

Spectrum Analyzer

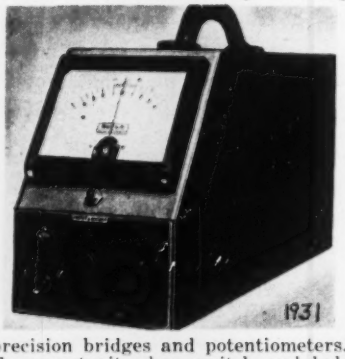
New "Rayspan Spectrum Analyzer" is said to combine "excellent resolution with a far higher analysis speed

than is possible with conventional instruments." Instead of sweeping a single gate over spectrum to be observed, it contains many narrow gates (or filters) adjacent in frequency and covering any desired spectrum. Signal to be analyzed is fed to all filters simultaneously; output of each filter is applied to stator of a capacitance commutator which, when scanned by rotor, yields output of all filters in frequency sequence. Speed of scan not limited by filter characteristic times.—*Equipment Eng'g Div., Raytheon Mfg. Co.*, 148 *California St., Newton* 58, *Mass.*

For more information circle **296** on inquiry card.

Null Indicator

New "ElectroniK Null Indicator," said to be "the first radical departure from the conventionally used galvanometers," speeds up resistance and potential measurement by utilizing



precision bridges and potentiometers. To operate it, close switch and balance bridge: balance point is indicated by return of pointer to zero, whereas light-beam galvanometers take much longer to cease oscillating or come back on scale.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia* 44, *Pa.*

For more information circle **297** on inquiry card.

PALMER
MERCURY ACTUATED

DIAL THERMOMETERS

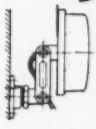
in 3 types to suit any requirements

PATENTED

Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 **Rigid Stem Dial Thermometer** tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)

2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.



3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensaton. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

Send for Bulletin 51-129 for details on the New Palmer Dial Thermometer.

PALMER
THERMOMETERS, INC.
Norwood Ave., Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle **70** on inquiry card.

Electrical Indicating Instruments

New complete lines of "Custom Panel Instruments" (non-ruggedized and non-sealed), "Sealed Panel Instruments" and "Ruggedized Panel

Instruments" are added to maker's "Ruggedized and Sealed (MIL-10304) Panel Instruments and Null Indicators." Available in a-c. and d-c. ranges in 1½, 2½, 3½ and 4½-in. sizes with interchangeable round or square bezels, front or rear zero adjustments, optional mirror scales.—*Phaostron Co., 151 Pasadena Ave., So. Pasadena, Calif.*

For more information circle **298** on inquiry card.

Electrical Indicating Instruments

New "Six-inch Custom Panel Meter," non-ruggedized and non-sealed, is for applications requiring accuracy of an expanded scale reading. Instru-

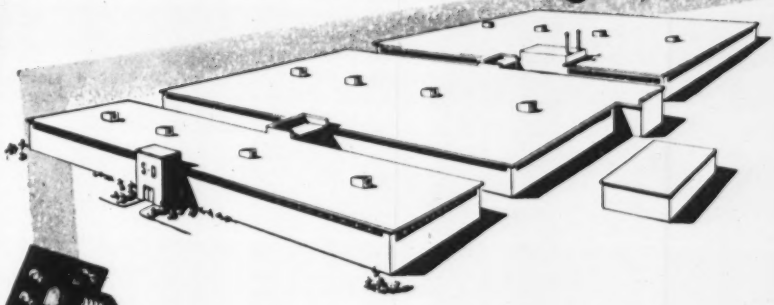
ments are available in a-c. and d-c. ranges and incorporate maker's basic movement as in "Ruggedized Meters," with exception of shock mounts.—*Phaostron Co., 151 Pasadena Ave., So. Pasadena, Calif.*

For more information circle **299** on inquiry card.

Wide-band CRO

New "Type 323 wide-band cathode-ray oscilloscope features high-precision measurement of both time and amplitude over entire range of gen-

Announcing...



A NEW PLANT

A modern building designed specifically for relay manufacture is another step in the continuing effort to improve Struthers-Dunn services and maintain maximum production of high quality products at favorable prices.

A NEW LOCATION

The entire Struthers-Dunn factory and headquarter offices have been moved to a new location, approximately 15 miles Southeast of the Philadelphia-Camden Area.

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STRUTHERS-DUNN, INC.

STRUTHERS-DUNN

5,348 RELAY TYPES

For more information circle **71** on inquiry card.

"pH at your fingertips..."

...nothing like it!

This revolutionary ANALYTICAL pH PROBE UNIT makes possible on-the-spot pH readings *anywhere*. No more trips to the laboratory, no supports, beakers holders or separate electrodes.

This PROBE UNIT has made possible a true pocket sized pH METER that simplifies pH determination and eliminates errors due to sampling techniques, turbidity, and presence of oxidizing or reducing agents.

No indicating solutions, measurement of sample or color matching are necessary.

Completely self-contained in waterproof ever-ready case with shoulder strap.

PRICE $125.00

Instrument size: 3x5-7/8 x 2-1/2 inches
Case size: 3-3/4 x 6-1/2 x 4-1/8 inches
Weight with accessories: 3 lbs.

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585 Main St., Chatham, N. J.

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For more information circle **72** on inquiry card.

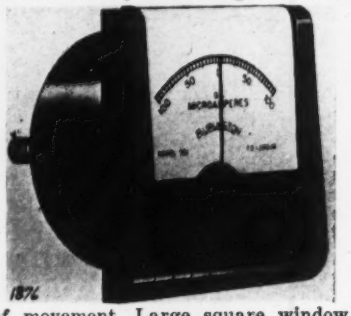
NEW INSTRUMENTS

eral laboratory applications. New sweep "notch" enables speeding by a predetermined factor any 2-in. portion of 4-in. trace; is movable along trace.—*Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more information circle **300** on inquiry card.

Plexiglass-front 2½-in. Electrical Instruments

New "Model 721" 2½-in. square semi-flush instruments have case front molded of Plexiglass: can be furnished entirely clear to give a view

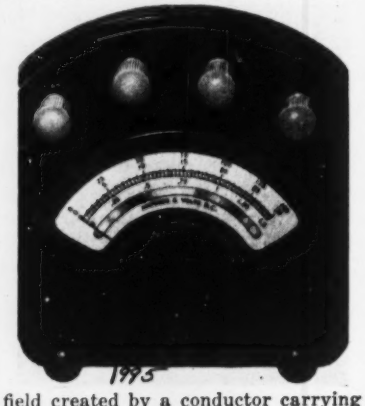


of movement. Large square window slopes backwards at a slight angle. Rim and lower third of case may be spray lacquered in any color and various finishes.—*Burlington Instrument Co., 151 N. Third St., Burlington, Iowa.*

For more information circle **301** on inquiry card.

Self-shielded Portable D-c. Instruments

New "Model 281" miniature portable d-c. instruments (accuracy within 1 percent) employ "Weston Core Magnet Mechanism" which provides such excellent shielding that magnetic



field created by a conductor carrying 15,000 amperes at a distance of 3 ft. from an instrument causes a temporary error in indication of less than 1 percent. Instrument can also be used close to magnetic materials without affecting accuracy; withstand a dielectric test of 2,600 v.ac. rms. between case and terminals in accordance with A.S.A. specs. Scales are hand-calibrated; mirror and knife-edge pointer eliminate parallax errors. Single and multi-range voltmeters, ammeters, and volt-ammeters.—*Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*

For more information circle **302** on inquiry card.

RC NETWORKS

SPECIAL NETWORKS FOR UNUSUAL REQUIREMENTS

- **Temperature stable**
- **Hermetically sealed**

A SOLUTION to your special filter problem may be in production. Typical standard items are:

SERIES 500 TWIN-T RC notch networks, accurate and stable, in the well-known parallel-T circuit. All common and many special null frequencies.

SERIES 410 SERVO LEAD networks combining derivative action with low pass hum and ripple filtering.

SPECIAL NETWORKS from our design library, or from your own design and specifications, can be maintained quickly and economically. Correspondence on application problems will be answered promptly.

Bulletins containing full engineering information are sent on request

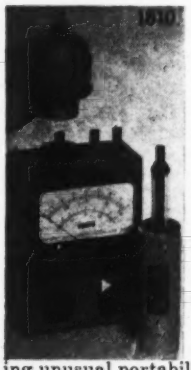
White

203 RIVERSIDE DRIVE
AUSTIN 4, TEXAS

For more information circle **73** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Range-extending VDRs

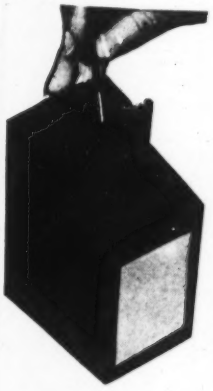


New "Models 2006 and 2007" resistive voltage dividers for maker's Vacuum Tube Electrometers have maximum inputs of 2,000 and 20,000 volts respectively, and input impedances of 10^{12} ohms. They make available a new type of high-impedance d-c. kilovoltmeter. Several unique features are cited, including unusual portability, polarity sensitivity, an extremely short time constant, and a wide selection of voltage ranges.—*Keithley Instruments*, 3868 *Carnegie Ave., Cleveland* 15, *Ohio.*

For more information circle **303** on inquiry card.

Oscillograph Galvanometers

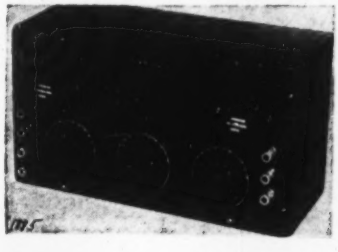
New "Series M," said to be "the most sensitive galvanometers yet produced for recording oscillographs," are ⅛-in. diam. by 2 21/32 in. long; are inserted directly into 14 numbered holes in oscillograph's magnet bank making all electrical connections automatically; are isolated from one another and from ground. Other features of 2¼ - in. - wide magnet bank include heater elements and thermostat; individual vertical adjustment of each galvanometer light spot without disturbing positions adjacent galvanometers; and no need to insert dummy galvanometers into vacant positions to maintain magnetic field. Optical lever is 11.8 in. (30 cm.).—*Heiland Research Corp.*, 130 *E. Fifth Ave., Denver* 9, *Colo.*



For more information circle **304** on inquiry card.

Attenuation Networks

New "690 Series Plug-In Attenuation Networks" permit input and output impedance to be changed by substituting plug-in pads of value desired; are available in either "T" or

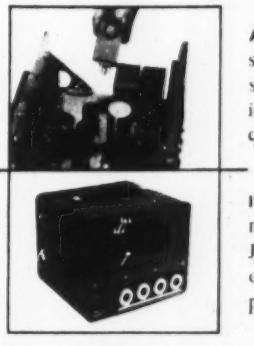


fast, accurate measurement

for production line and laboratory

CEC Type 1-117 Vibration Meter

Accommodating up to 3 plug-in, high-pass filters for the elimination of unwanted low-frequency interference, the new CEC 1-117 Vibration Meter is unexcelled for production-line or laboratory measurement of vibratory displacement or velocity. Rugged, accurate and reliable, the instrument is suitable both for field operation and rack-mounted service. Input signals from self-generating pickups, either attached to, or held against the vibrating structure, are amplified and read on a large, calibrated meter. For wave form analysis the meter output can be fed to a cathode-ray oscilloscope or a recording oscillograph. For continuous monitoring the CEC 1-117 can be used to activate warning devices or to cut off the power, thus preventing vibration damage. For vibratory velocity, displacement and frequency determination investigate CEC's 1-117. Write for CEC Bulletin 1538-X1.



ACCESSORY PLUG-IN HIGH-PASS FILTERS, individually selected or removed from circuit by 4-position switch, cut off at 30, 70, and 110 cps, make the 1-117 ideal for applications where unwanted low frequency vibration interferes with the desired signal.

INDIVIDUAL QUICK DISCONNECTS Locking type connectors are provided for the four input channels. Jacks facilitate connection of output to recording oscillograph or external meter. Storage space for power cable recessed into rear panel.

Consolidated Engineering CORPORATION

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

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For more information circle **74** on inquiry card.

The Duplex Function Plotter

—plots two variables vs a third

NEWEST of the many modifications of the *ElectroniK* recorder for research purposes is this two-pen version of the famous Function Plotter. It has three independent measuring systems; one for each of the horizontally moving pens, and one for the vertically moving chart. It is thus able to draw two simultaneous curves representing the relationship $x,x'=f(y)$.

The Duplex Function Plotter gives research men better data in the testing of missiles, engines, nuclear reactions and many other studies. It provides a continuous plot of two related functions on a single chart . . . eliminates the labor and possibility of human error in replotting from two separate records.

Input to either pen or to the y-axis can be practically any variable that can be converted to a d-c signal. All three inputs can be of different calibrations.

Two new instruments to

The *ElectroniK* Null Indicator

—the successor to the galvanometer

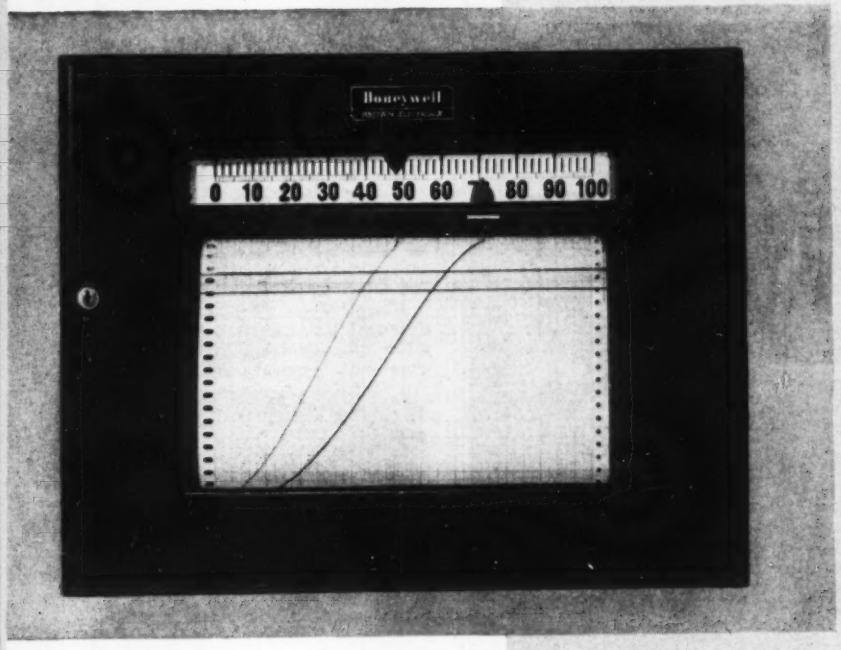
THE LAB MAN'S ideal null balance d-c detector, the *ElectroniK* Null Indicator is completely free from all the limitations of galvanometers. It speeds bridge-balancing operations, because there's no "loss of spot" from excess signal. It takes heavy overloads without damage. It's unaffected by vibration, and needs no special mounting or leveling.

The Null Indicator has high sensitivity and quick response. It indicates in less than one second . . . ideal for production testing. Its stable electronic circuit holds steady zero after warm-up. Just plug it into any 115-volt, 60 cycle line and it's ready to use.

Current sensitivity is 0.6×10^{-9} amperes per millimeter . . . voltage sensitivity 1 microvolt per millimeter. Input impedance is 1500 ohms. Economical price places the *ElectroniK* Null Indicator within the reach of any research budget.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

For more information circle **75** on inquiry card.



accelerate research

Your nearby Honeywell field engineer will be glad to discuss how these and other Honeywell instruments can help to save time and routine labor in your research work. Call him today . . . he's as near as your phone.

● **REFERENCE DATA:** Write for Data Sheet No. 10.0-7, "*ElectroniK* Duplex Function Plotter," and for Data Sheet No. 10.0-12, "*ElectroniK* Null Indicator."

For more information circle **75** on inquiry card.

MINNEAPOLIS
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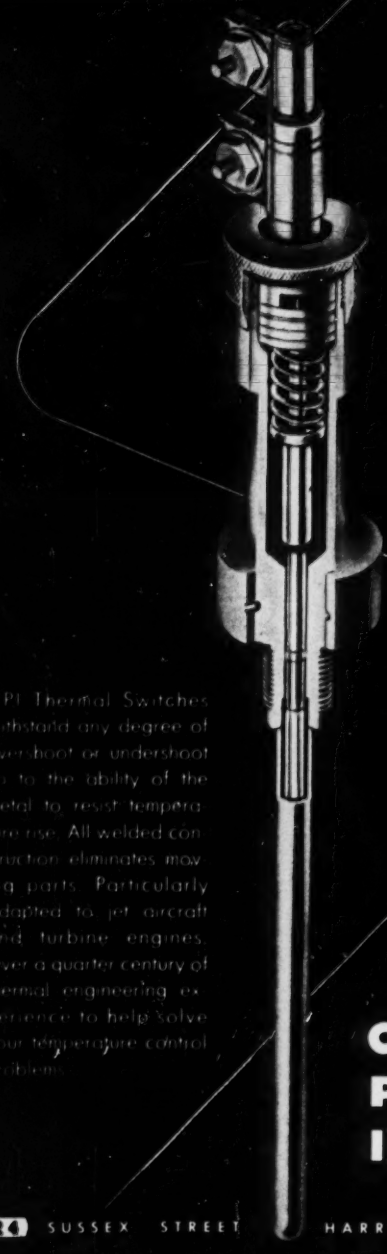
BROWN INSTRUMENTS
First in Controls

1200°F..1500°F..2000°F!

CPI super high-temp thermal switch



- FASTER RESPONSE DUE TO LOWER THERMAL MASS
- MAINTAINS UNUSUALLY CLOSE TEMPERATURE CALIBRATION
- OPERATING TEMPERATURES TO 1700°F
- OVERSHOOT TO 2000°F
- MAXIMUM VIBRATION RESISTANCE
- CONSTRUCTED OF HIGH TEMPERATURE ALLOYS
- LIGHTWEIGHT (Approx. 6 ounces)
- PLATINUM IRIDIUM CONTACTS FOR LONG LIFE

CPI Thermal Switches withstand any degree of overshoot or undershoot up to the ability of the metal to resist temperature rise. All welded construction eliminates moving parts. Particularly adapted to jet aircraft and turbine engines. Over a quarter century of thermal engineering experience to help solve your temperature control problems.

CONTROL PRODUCTS INC

124 SUSSEX STREET HARRISON · NEW JERSEY

For more information circle **76** on inquiry card.

NEW INSTRUMENTS

"Balanced H" circuits. Range: 110 db in 1-db steps on 2-dial series, or 111 db in 0.1-db steps on 3-dial series. Card-type non-inductive winding gives frequency range of zero to 50 kc. (above 50 kc with a slight decrease in accuracy).—*Daven Co.*, 191 *Central Avenue, Newark, N. J.*

For more information circle **305** on inquiry card.

Short-wave Converter

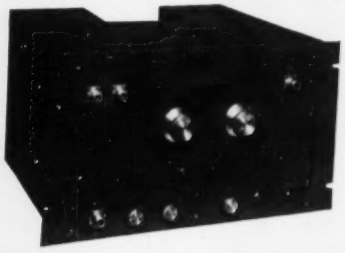
New "Type MCL-50/50 Signal-Splitter" is a complete variable-bandwidth single-sideband converter to be used with general-purpose communi-

cations receivers; provides jam-free-bandwidth for all long-range reception of double- or single-sideband, program, voice or FSK transmissions.—*J. L. A. McLaughlin Corp., La Jolla, Calif.*

For more information circle **306** on inquiry card.

Sweep Generator

New "Model 610 High Speed Sweep Generator," for CR indicators or other applications requiring a rapidly-ris-

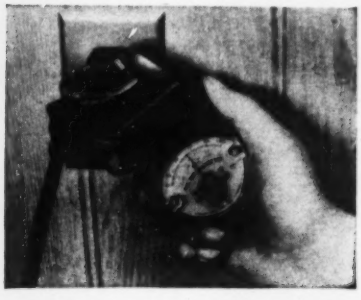


ing linear voltage, provides continuously-adjustable sweep speeds of 0.05 to 500 cm./usec.; can be triggered for single or repetitive sweeps; will also provide a brightening pulse and gate outputs. Flexibility and versatility make practical the study of short-range radar return signals, contact phenomena, and other extremely fast signals.—*Spencer-Kennedy Laboratories, Inc.*, 186 *Massachusetts Ave., Cambridge* 39, *Mass.*

For more information circle **307** on inquiry card.

Adapter for Snap-around Volt-ammeter

New "Amprobe Energizer Model A-40" makes possible instant current and voltage readings at wall outlet, when

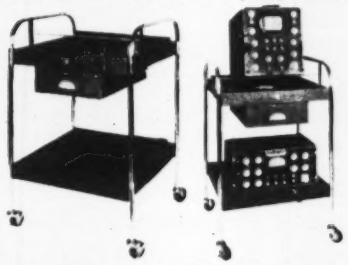


used in conjunction with a snap-around volt-ammeter; has receptacles for measuring line voltage at outlet while appliance is connected to line. Illustration shows use for measuring current.—*Pyramid Instrument Corp., Lynbrook, N. Y.*

For more information circle **308** on inquiry card.

All-purpose Dolly

New "Model OD-1" all-purpose dolly has many uses in lab and on production line. Basic dolly has two 24 x 24-in. steel shelves (19¾-in. between shelves). Available accessories: drawer assembly (with provisions for lock), five-position bar lift which tilts instrument; power outlet strip.—*Browning Laboratories, Inc., Winchester, Mass.*



For more information circle **309** on inquiry card.

Sawtooth Generator

New "Model 54 Automatic Oscilloscope Sweep" locks onto a signal of 0.1 to 50 volts in frequency range of 20 to 30,000 cps, and automatically generates a perfectly-synchronized sawtooth sweep voltage of constant amplitude, fed to *X* axis amplifier. It is said to "halve the time required to use a CRO" because CRO user does not have to constantly readjust coarse and fine sweep frequency and synchronizing controls. Input impedance 1 megohm. Sweep frequency always one-half signal frequency, so that two cycles of signal are displayed.—*Audio Instrument Co., Inc., 133 W. 14th St., New York 11, N. Y.*

For more information circle **310** on inquiry card.

Cathode Follower

New "Type 1523" is a miniature plug-in resin-encapsulated high-efficiency dual-type cathode follower designed for coupling low output impedances with high input impedances. It utilizes Type 5687 tube's properties to provide two independent cathode followers within a single unit; is said to be ideally suited for joining flip-flops, oscillators, and voltage amplifiers, with low-impedance transmission lines, matrices, filters, or capacitive circuits where fast rise times are desired.—*The Walkirt Co., 145 West Hazel St., Inglewood, Calif.*

For more information circle **311** on inquiry card.

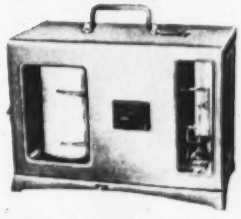
Cathode Follower

New "Model TG-1 Multi-channel Cathode Follower," designed for instrument work, handles both a-c. and d-c. signal circuits in applications involving strain-gage, piezoelectric and other such pickups; has two regulated

DEFINED

AIR INSTRUMENTATION BY BENDIX-FRIEZ

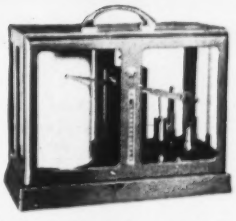
FOR RECORDING TEMPERATURE, HUMIDITY



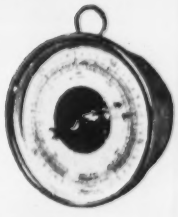
HYGRO-THERMOGRAPH The leader in its field. Noted for precise accuracy and long-time dependability. Portable, easy to operate. Widely used in laboratories, factories and offices.

PORTABLE TEMPERATURE, HUMIDITY RECORDER Rugged, compact design. Ideally suited for use in small space and difficult locations. Provides convenient 3 x 5 charts for 10 or 30 hour records.

FOR CHECKING BAROMETRIC PRESSURE



MICROBAROGRAPH A key meteorological instrument. Records atmospheric pressure to within 0.01 inch mercury. Record chart expanded 2½ times for greater visibility.



ANEROID BAROMETER Inexpensive, dependable, easy-to-read. Shows pressure and barometric tendency. Housed in handsome brass case. Favored by professionals and amateurs alike.

FOR MEASURING WIND SPEED, DIRECTION

SINGLE CHART AEROVANE RECORDER New flush mounted recorder for wind speed and direction. Each gust or lull, from breeze to hurricane, accurately ink plotted and recorded on a single continuous strip chart.

AEROVANE Indicates and records wind speed and direction. Recognized as "best all-purpose wind measuring instrument yet devised." Readily installed and easily maintained.

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AVIATION CORPORATION

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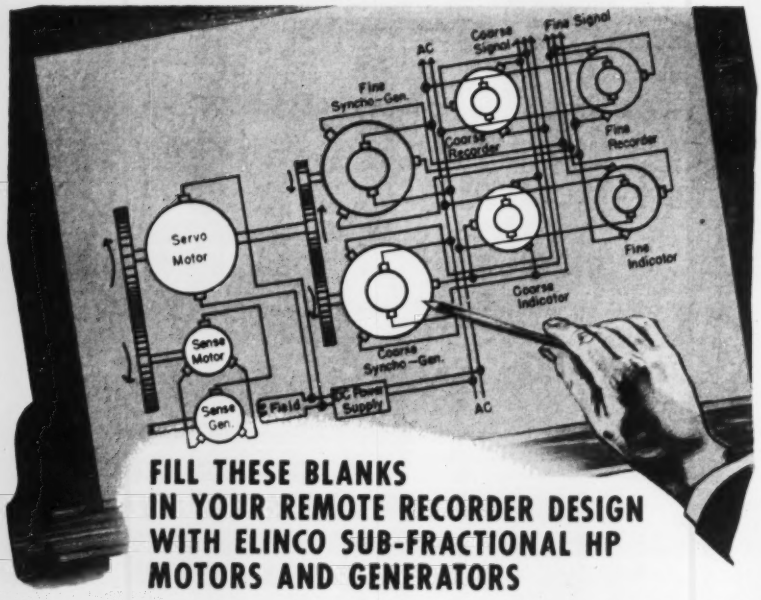
For more information circle **77** on inquiry card.



FILL THESE BLANKS IN YOUR REMOTE RECORDER DESIGN WITH ELINCO SUB-FRACTIONAL HP MOTORS AND GENERATORS

Elinco designs and manufactures hundreds of variations of sub-fractional horsepower motors and generators to solve accurately nearly *ANY* specific problem, virtually *ANY* specific requirement, called for by your electrical design.

All Elinco units feature instrument-type precision ball bearings. Every unit is balanced dynamically . . . individually tested under specific load conditions. Step-by-step inspection of every component — assures high-precision on *ALL* parts.

Hundreds of variations on over 650 basic models of sub-fractional horsepower motors and generators engineered by ELINCO in the last 25 years are at your disposal. We may have already solved your individual problem. If not, we will design and manufacture motors and generators incorporating any physical or electrical variation to meet your specific requirements.

Take advantage of Elinco's experience to solve your special instrument problem. See ELINCO for high precision sub-fractional horsepower motors and generators, 1/3000 to 1/6 hp, built to your specifications.

But please outline your problem in *full* detail when requesting quotations or literature. We have NO STOCK UNITS, no "mass-produced" units available. Every ELINCO unit is a precision instrument, specially designed and manufactured to meet your highest specific performance standards.

ELINCO MOTORS & GENERATORS

Ratings:	1/3000 to 1/6 hp
Types:	AC • DC • Universal • Servo • Self-Synchronous
Phases:	One-, two-, and three-phase
Windings:	Compound • Shunt • Series • Separately Excited Split Field • Permanent Magnet • Reluctance Hysteresis • Stabilized Hysteresis Induction • Drag Cup
Services:	1-, 2-, 3-, & 5-speed synchronous AC Dynamically Braked • Adjustable Speed Governor Controlled • Self-Starting • Reversible
Frames:	Available in all regular frame types or specially designed according to specifications

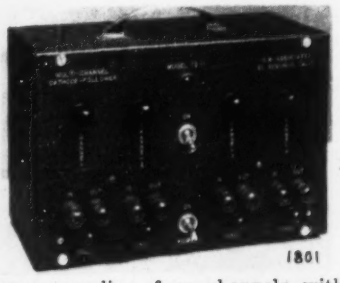
Over A Quarter Century Of Precision Manufacturing

ELINCO **ELECTRIC INDICATOR COMPANY, INC.**

106 Camp Avenue • Springdale • Conn.

For more information circle **78** on inquiry card.

NEW INSTRUMENTS



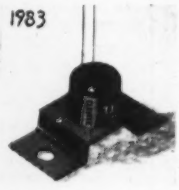
power supplies, four channels with individual input and output terminals, d-c. balance control. Channel-to-channel interaction: adjacent, 1 percent; non-adjacent 0.1 percent.—*G. W. Associates, P.O. Box 2263, El Segundo, Calif.*

For more information circle **312** on inquiry card.

ELECTRICAL AND ELECTRONIC INSTRUMENTS

High-power Transistor

New "Experimental Type X78," available in "sizable quantities," is a *p-n-p* diffused junction transistor said to have unusual capabilities. Maker guarantees minimum power gain of 10 db at room temperature when used in recommended circuit.—*Transistor Products, Inc., Snow & Union Street, Boston 35, Mass.*



For more information circle **313** on inquiry card.

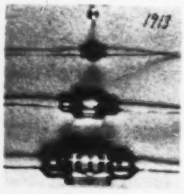
Bonded Germanium Diodes

New "CK739" and "CK742" are first two types in a new line of bonded germanium diodes said to be of interest to computer engineers and others requiring diodes with "an unusually high ratio of back to forward resistance combined with very low forward resistance."—*Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **314** on inquiry card.

Germanium Diodes

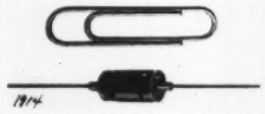
New miniature germanium diodes combine high acceleration resistance of junction diodes with small capacitance values of normal point contact diodes. Nine types available, 3 to 12 ma. d.c. at plus 1 volt; power dissipation 40 mw; temperature range from −55 to 85 C.; operate in ranges of 50 Mc. —*Intermetal Corp., 120 Wall St., New York 5, N. Y.*



For more information circle **315** on inquiry card.

High-temperature Diodes

New "Red Dot Series" germanium diodes are said to have forward and reverse characteristics far superior to those of conventional diodes at high



operating temperatures. Sealing: exposure to over 95 percent relative humidity for 500 hours at temperatures from 0 to 85 C. will not appreciably change back resistance or cause appearance of hysteresis.—*Inter-National Rectifier Corp.*, 1521 *E. Grand Ave., El Segundo, Calif.*

For more information circle **316** on inquiry card.

Tetrode Transistors

New high-frequency grown-junction tetrode transistors are said to make "possible for the first time, the commercial adaptation of the transistor to radio, television and communications equipments." Originally developed by Bell Telephone Laboratories; now offered to industry for immediate delivery by company which "was the first to make commercially available junction triode transistors."—*Germanium Products Corp.*, 26 *Cornelison Ave., Jersey City, N. J.*

For more information circle **317** on inquiry card.

Stable Transistors and Germanium-silicon Alloy

New line of transistors is announced, said to be completely stable and long-life. "Stabilized germanium," it is said, will permit great expansion in use of transistorized electronic equipment. Maker also announces "important new germanium-silicon alloy" for transistors operable at high temperatures.—*Sylvania Electric Products Inc.*, 1740 *Broadway, New York* 19, *N. Y.*

For more information circle **318** on inquiry card.

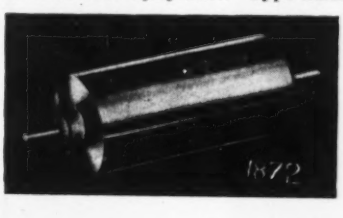
Sealed Germanium Diodes

New hermetically-sealed ceramic germanium diodes, including three JAN types (1N69, 1N70 and 1N81) and some commercial computer types, are in production. Other commercial types will be available in a few months. All features of G-E plastic-case diodes have been preserved: platinum-rhuthenium whisker is welded to germanium pellet. Hermetic seal is metal to ceramic. Gas-tight ceramic cases with metalized ends permit solder seal to nickel pins. New diodes exceed requirements of JAN humidity specs.—*General Electric Co., Electronics Park, Syracuse, N. Y.*

For more information circle **319** on inquiry card.

Ultrasonic Delay Lines

New solid ultrasonic delay lines are said to provide precise delay intervals for electronic equipment. "Type SDL-



MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED

STANDARD

MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only* — normally open or normally closed.

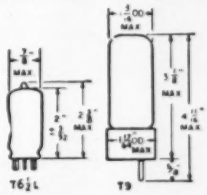
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

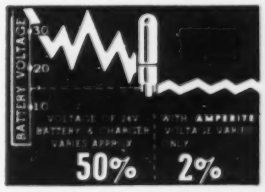
TYPES: Standard Radio Octal, and 9-Pin Miniature.

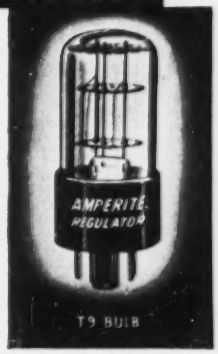
PROBLEM? Send for Bulletin No. TR-81

BALLAST-REGULATORS

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.







Maximum Wattage Dissipation: T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St. W., Toronto 2B

For more information circle **79** on inquiry card.

PRODUCT PERFORMANCE AND ACCEPTANCE REQUIRE CAREFUL COMPONENT COMPARISON

Compare AEMCO RELAYS

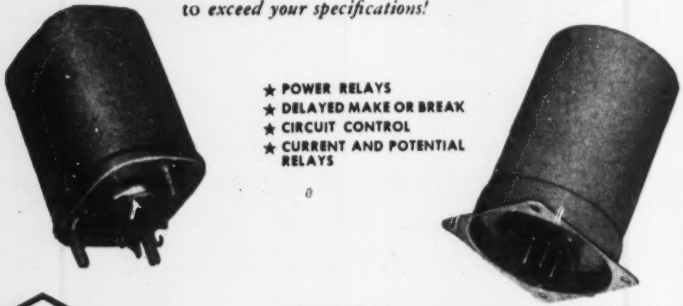
OPEN OR CAN TYPE MIDGETS AND SUB-MIDGETS.

A WIDE VARIETY OF SPRING AND COIL COMBINATION, OPERATING POTENTIALS AND CONTACT RATINGS.

How do you compare relays? Comparison can be made on the basis of craftsmanship, uniformity of performance, dependability . . . and AEMCO invites such comparison. Comparative quality is relative but absolute quality is more certain!

We believe that the long and continuous servicing of more than one hundred top names of American Industry establishes the uniform dependability of AEMCO 'Engineered' RELAYS.

If one of the hundreds of stock AEMCO Relays does not exactly fit your requirements, we will design and manufacture to meet your particular needs . . . to *exceed your specifications!*



★ POWER RELAYS
★ DELAYED MAKE OR BREAK
★ CIRCUIT CONTROL
★ CURRENT AND POTENTIAL RELAYS

WRITE TODAY *for complete information on AEMCO Relays to meet your requirements and exceed your expectations!*

AEMCO Automatic Electric MFG. CO.

58 STATE STREET · MANKATO, MINN.

For more information circle **80** on inquiry card.

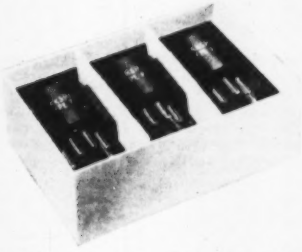
NEW INSTRUMENTS

-15" 1000 yards, 3.051 usec.; "Type SDL-16" 2000 y., 6.102 usec.; each unit in a hermetically sealed case. Carrier frequency 30 Mc. Attenuation 26 db into 1000 ohms; bandwidth 8 Mc. Available immediately.—*Bliley Electric Co., Union Station Bldg., Erie, Penna.*

For more information circle **320** on inquiry card.

Pulse-transformer Package

New "SP-1 Transformer Sample Package" contains one each of "Types PT-1, PT-2 and PT-3," for immediate

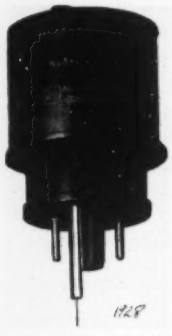


availability for experimental circuits, development models or prototypes.—*Berkshire Labs, 508 Beaver Pond Rd, Lincoln, Mass .*

For more information circle **321** on inquiry card.

Miniature C-w. Magnetron

New "6444" cw magnetron resembling physically a standard receiving tube and operating from a plate supply of 450-500 volts and a heater supply of 6 volts is now available for use at a range of 9800 to 10,000 Mc. It incorporates new long life Philips dispenser-type cathode and delivers 1 watt of cw energy into a standard klystron type output.—*Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.*



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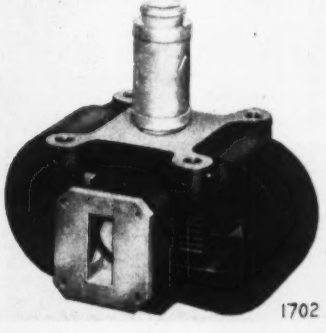
For more information circle **322** on inquiry card.

Magnetron

New model of "4J52" magnetron incorporates improvements while retaining mechanical and electrical interchangeability. Oxide-coated cathode has been replaced by new Philips



1702

dispenser-type "practically indestructible." A bifilar winding heater reduces tube noise. All glass in tube has been replaced by ceramic.—*Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.*

For more information circle **323** on inquiry card.

Double-bridge Rectifier

New miniature rectifier contains two full-wave selenium bridge rectifiers and associated resistors, designed to operate as a phase comparator and packaged to withstand high shock and vibration. Weight, slightly over ½ oz.—*Equipment Eng'g Div., Raytheon Mfg. Co., 148 California St., Newton 58, Mass.*

For more information circle **324** on inquiry card.

Precision Capacitors

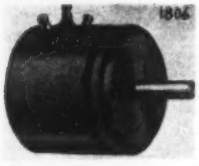
New "Type 722-MD and -ME" precision capacitors, intended for use in substitution methods of measurement, are calibrated in terms of capacitance

difference rather than terminal capacitance. Each model has two sections, one section having one-tenth range of other. "Type 722-MD" has capacitance-difference ranges of 0 to 1050 and 0 to 105 uuf.; "Type 722-ME" ranges of 0 to 105 and 0 to 10.5 uuf.—*General Radio Co., Cambridge 39, Mass.*

For more information circle **325** on inquiry card.

Precision Low-torque VDRs

New models of "Series T" miniature "Helipots" are said to be greatly improved. New aluminum-alloy housing and lids, blue alumilited, provide dimensional stability and maximum heat dissipation so that maximum operating temperature has been raised to 105 C. ambient. Power rating has been increased to 1.2 watts at 40 C. ambient and electrical noise reduced materially through several design improvements. Resistance range has been extended to provide values from 10 to 100,000 ohms.—*Helipot Corp., 916 Meridian Ave., South Pasadena, Calif.*



For more information circle **326** on inquiry card.

Ten-turn VDRs

New "901-903 Series Precision Ten-turn Potentiometers" feature adjustable contact drive assembly said to provide "greater accuracy in the four basic types of linearity without additional modification" and permitting

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TO YOUR AIRCRAFT
INSTRUMENTATION PROBLEMS
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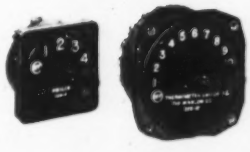
COMPLETE TEMPERATURE MEASURING SYSTEMS FROM A SINGLE QUALIFIED SOURCE . . . TO MEET AN, MIL or YOUR OWN SPECIFICATIONS

PYROMETER RELAY

For jet tailpipe measurements. Requires no auxiliary vacuum tubes, assuring maximum dependability and ease of maintenance. Incorporates temperature indicator and warning alarm with adjustable index. For use with C-A thermocouples over the 0-1000° C range. Other ranges on special order. Meets requirements of MIL-I-5084(Aer).

TEMPERATURE INDICATORS

Complete range of indicators for measuring cylinder head, tailpipe and bearing temperatures. Single or dual types, conventional or sealed instruments available.



ROTARY SELECTOR SWITCHES

Specially designed for aircraft temperature measurements, with extremely low contact resistance to insure reliable operation under low temperature — high altitude conditions. Sizes to four positions conform to AND10403; sizes from six to eighteen positions conform to AND10401.

INSTALLATION COMPONENTS

A complete line of accessory components necessary for proper installation of temperature measuring equipment is available to meet AN, MIL or CAA specifications, including: Firewall Connectors, Lead Resistors, Terminals, Thermocouples, Leads, Lead Wires and Harnesses.

ALSO . . . *Aircraft Instrument Testing Equipment.* Megohmeter for checking insulation of wiring and electrical equipment . . . Ignition Harness Tester for determining harness insulation breakdown . . . Thermocouple Thermometer Test Sets . . . Resistance Thermometer Test Sets . . . Synchro-Phasing Testers . . . Slaved Gyro Testers . . . Compression Testers . . . Wheatstone Bridges.

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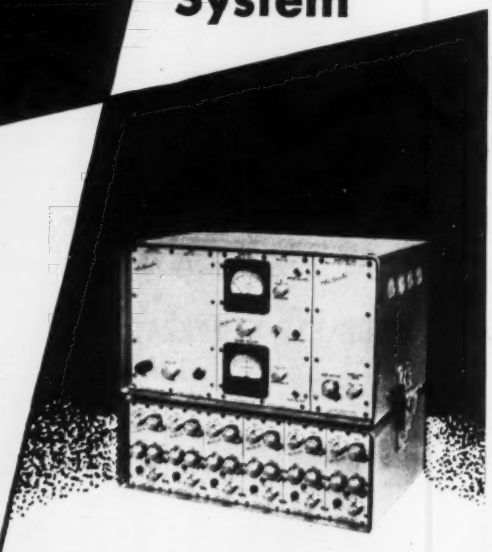
Manufacturers of Precision Instruments for Over a Quarter-Century
NINE LIBERTY STREET ● NEWARK 5, NEW JERSEY

For more information circle **81** on inquiry card.

Heiland Amplifier System

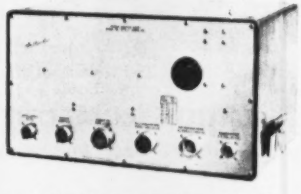
The most complete, yet easiest to operate amplifier system ever developed for oscillographic recording



Model 119 Carrier and Linear or Integrating Amplifier System.

Heiland's model 119 Amplifier System, used in conjunction with Heiland Recording Oscillographs, has received wide acclaim from engineers for its extreme versatility, accuracy and simplicity of operation in the amplification of static and dynamic current phenomena.

This small, compact instrument, which can be provided for either rack, table, or shock mounting with available accessories, is housed in a rugged, yet lightweight cast aluminum case finished in attractive silver-gray gloss enamel. For complete specifications write or wire for our Bulletin 107.



Power Supply Assembly (Rear View)

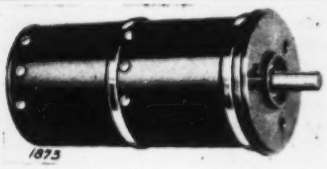
Amplifier Assembly (Rear View)

Complete information on other Heiland products will be supplied on request.

Heiland Research Corporation 130 East Fifth Ave., Denver, Colorado

For more information circle **82** on inquiry card.

NEW INSTRUMENTS

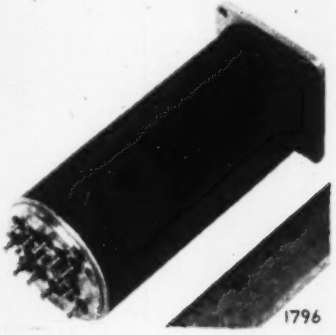


either or both mechanical stops to be used as phasing points. Other features: no backlash between shaft rotation and electrical rotation; wear compensation; fine resolution obtained by Kohlrausch winding resistance wire with 49-in. helix molded into housing; space-saving terminals located 30 deg. apart.—*George W. Borg Corp., 120 S. Main St., Janesville, Wis.*

For more information circle **327** on inquiry card.

Precision VDR

New "85174 Voltage Divider" for airborne and industrial electronic applications is said to be extremely

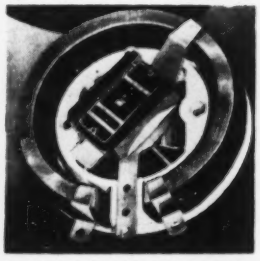


stable, offering uniform performance even when exposed to severe temperature changes, corrosive atmosphere and high humidity. Any number of voltage divisions up to 23—*G. M. Giannini & Co., 39 Main St., East Orange, N. J.*

For more information circle **328** on inquiry card.

Ring Rheostat

New 300-watt "Bulletin 1116 Vitrohm Ring Type Rheostats" are for use in a-c. and d-c. circuits where smooth, accurate current control is es-



sential, particularly where "stepped" rheostats do not furnish sufficiently close adjustment: generator and motor field, electron-tube, battery-charging, oven and lamp-dimming control.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

For more information circle **329** on inquiry card.

10-to-25-watt Resistors

New "Stand-Ohm" resistors for top-of-chassis mounting have integrally mounted bracket conducting heat

to chassis, affording cool over-all operation. Ratings of 10, 15, 20 and 25 watts in heights of 1½, 2, 2½ and 3 in. respectively, all 19/32 diam. to fit in ⅝ chassis cutout. Straight resistance values or with up to two taps.—*Model Engineering & Mfg. Inc., 2800 N. Milwaukee Ave., Chicago 18, Ill.*
For more information circle **330** on inquiry card.

Severe-service Resistors

New "Series S Econ-Ohm" resistors are individually wound with best-grade resistance wire available, on non-hygroscopic ceramic cores to which are attached tinned copper leads in such a way that stresses put on them in any way will not injure resistance wire. Coated with maker's own newly-developed silicone cement, units withstand 90-95 percent relative humidity; temperature to 275 C. Standard ratings 3 to 20 watts.—*Model Engineering & Mfg., Inc., 2800 N. Milwaukee Ave., Chicago 18, Ill.*
For more information circle **331** on inquiry card.

Deposited-carbon Resistors

New "CARB-OHMS," for high-frequency applications, also meet need for closely-matched units for computer network and other applications.

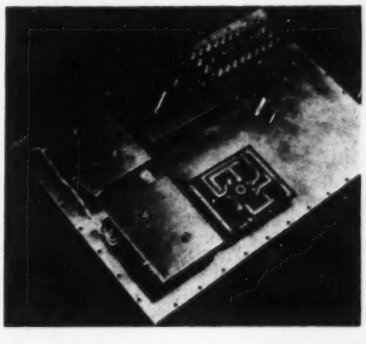
Available hermetically sealed in glass, conforming to MIL-R-10509; and clad in humidity-impervious Kel-F and Vinyl casings. Wattage rates range from ¼ to 2 watts; resistance 20 ohms to 200 megohms.—*Phaostron Co., 151 Pasadena Ave., So. Pasadena, Calif.*
For more information circle **332** on inquiry card.

Non-inductive Resistors

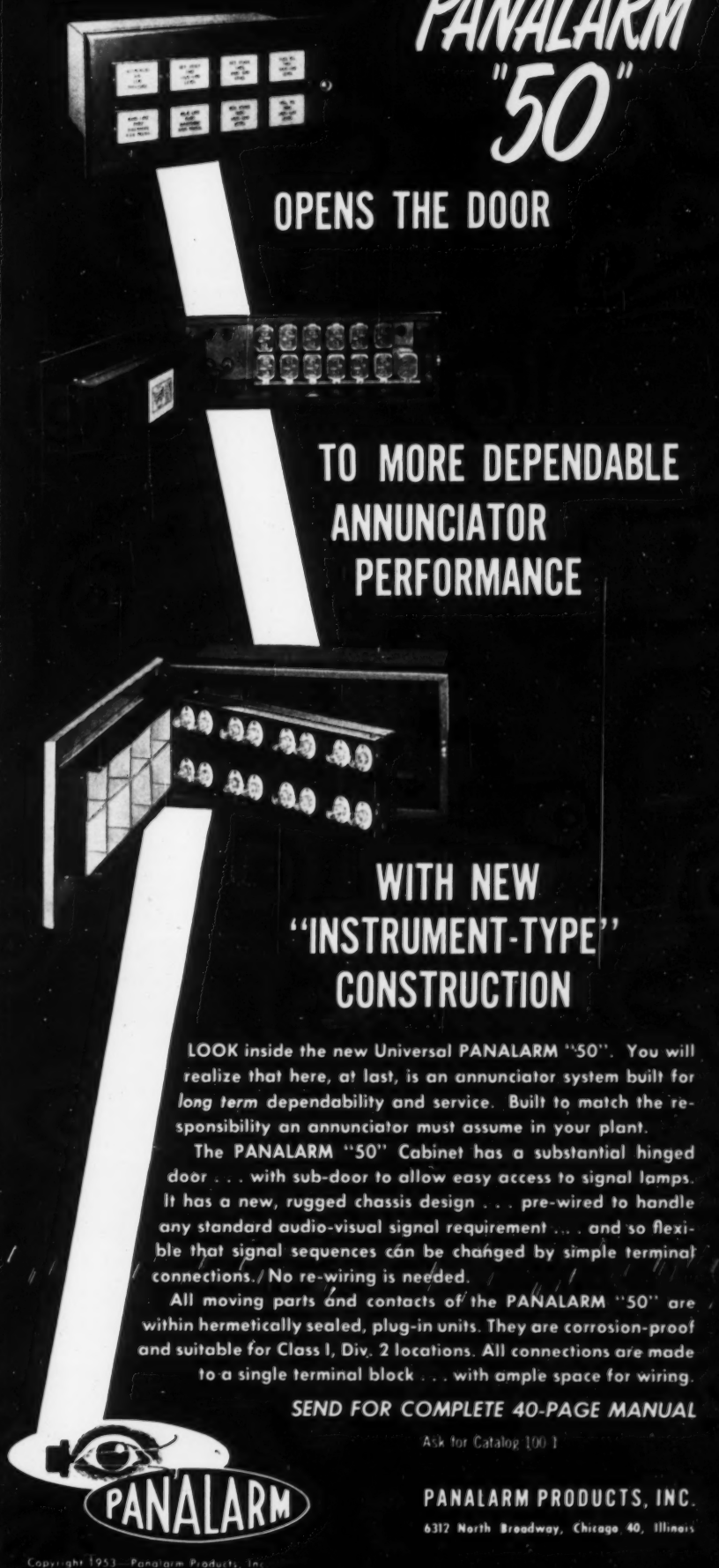
New precision resistors are available in accuracies of 1, 0.5, and 0.1 percent in standard value ranges from 0.1 ohm to 1 megohm; are wound non-inductively on non-hygroscopic ceramic bobbins and impregnated for moisture protection; temperature coefficient of 0.000025 per deg. C. Nine power ratings from ¼ watt to 1 watt. Standard units in values under 800 ohms are wound of Manganin wire; over 800 ohms Evanohm; special alloys available; also special units with values under 0.1 ohm and over 1 megohm.—*K-F Development Co., 2667 Spring St., Redwood City, Calif.*
For more information circle **333** on inquiry card.

Graphic Circuits

New "Tri-Dexes" (standard printed circuit boards) cut costs in electronic development laboratories. Six standard models provide for most tubes and



Circle **83** on inquiry card. ⟶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"50"
OPENS THE DOOR
TO MORE DEPENDABLE
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PERFORMANCE
WITH NEW
"INSTRUMENT-TYPE"
CONSTRUCTION
LOOK inside the new Universal PANALARM "50". You will realize that here, at last, is an annunciator system built for long term dependability and service. Built to match the responsibility an annunciator must assume in your plant.
The PANALARM "50" Cabinet has a substantial hinged door . . . with sub-door to allow easy access to signal lamps. It has a new, rugged chassis design . . . pre-wired to handle any standard audio-visual signal requirement . . . and so flexible that signal sequences can be changed by simple terminal connections. No re-wiring is needed.
All moving parts and contacts of the PANALARM "50" are within hermetically sealed, plug-in units. They are corrosion-proof and suitable for Class I, Div. 2 locations. All connections are made to a single terminal block . . . with ample space for wiring.
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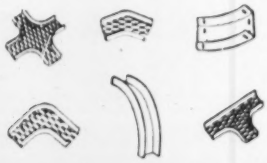
for the support of INSTRUMENT TUBING

Instrof is a standard system of completely designed prefabricated Trough which may be easily laid out and quickly and economically erected at the job site to give light, strong mechanical protection and continuous support for instrument tubing.

Standard fittings include tees, elbows, risers, crosses and other items which allow any change of direction or elevation to be made easily; special pieces can be fabricated for unusual requirements. The entire system can be installed in an extremely short time to conform to almost any plant layout.

Why not call in an Instrof Engineer who will be glad to assist you in planning your installation: In the meantime write for full details—ask for Bulletin 51.



INSTROF INCORPORATED

4923 PENTRIDGE ST.
PHILADELPHIA 43, PA.

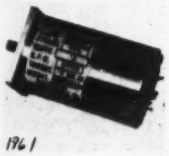
For more information circle **84** on inquiry card.

basic circuits; a seventh is universal for filtered power supplies. Each "Tri-Dex" mounts directly on a tube socket, provides marked preconnected eyelets for all resistors and capacitors for each basic circuit.—*Tri-Dex Co., P.O. Box* 1207, *Lindsay, Calif.*

For more information circle **334** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Low-inertia Servomotor



New servomotor was designed for application requiring high acceleration. Guaranteed minimum starting torque 0.6 oz.-in., measured average acceleration 26,500 rad./sec.^{2}. A tachometer generator is incorporated in design for applications requiring speed feedback. No-load speed 10,500 rpm. At no load, motor will accelerate to full speed in 0.03 sec.—*Equipment Eng'g Div., Raytheon Mfg. Co.,* 148 *California St., Newton* 58, *Mass.*

For more information circle **335** on inquiry card.

Two-speed Servomotor

New servomotor features two speeds obtained by pole changing which is accomplished by simple connection changes: 11,000 and 5500 rpm. with a 400-cps. motor. Stalled torques 0.13 and 0.35 oz. in. with high- and low-speed connection.—*Equipment Eng'g Div., Raytheon Mfg. Co.,* 148 *California St., Newton* 58, *Mass.*

For more information circle **336** on inquiry card.

Motor-blower Assembly

New miniature motor-blower assembly is said to supply 24 cfm. free air delivery under continuous duty. PM

motor rated at 6 to 115 volts dc.; speed 10,000-13,000 rpm, with 0.50 amp. Can be equipped with a radio noise filter.—*The Pioneer Electric and Research Corp., 743 Circle Ave., Forest Park, Illinois.*

For more information circle **337** on inquiry card.

Servo Amplifier and Motor

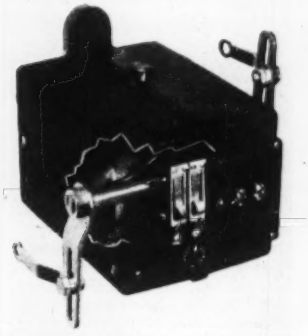
New "Type SA 118 H" miniaturized servo amplifier is of plug-in hermetically-sealed type and is designed to control its companion 400-cps. two-phase servomotor requiring 2 watts input to control phase. Among claimed "advantages over most types in current use": gain about 7000; no ex-

ternal d-c. supply required; only slightly larger than a pack of cigarettes; specially-designed "Type PS134 Power Supply" is of same miniaturized size and bases of these two components nest together. "Type 17ID2-8 Damped Control Motor," designed as a companion, eliminates tachometer cogging or static error and, gives servo loop stability.—*Servomechanisms, Inc., Post and Stewart Aves., Westbury, N. Y.*

For more information circle **338** on inquiry card.

Damper Motor

New model of maker's "No. 315 Lifetime Damper Motor" has moving parts reduced 50 percent; has been adapted to such jobs as operation of



ventilating louvres, temperature-control valves, etc. It offers simultaneous movement in two directions; is said to have advantage of relieving thermostat or other command device of all electrical load while motor is in operation. Maximum force at extreme radius is 20 lbs.—*Gleason-Avery, Inc., Auburn, N. Y.*

For more information circle **339** on inquiry card.

50-amp. Relay

New "PR 11000 Series 50 Amp Relay" is a sealed s-p.s-t. unit built to meet MIL-R-6106. Basic application is that of a magnet switch for remote control of currents up to 50 amps continuous duty. Nominal operating voltage 24 to 28.—*Phaostron Co., 151 Pasadena Ave., So. Pasadena, Calif.*

1942

For more information circle **340** on inquiry card.

Miniature Sealed Relay

New "PR 9100 Series" miniature hermetically-sealed d-p-.d-t. relay, designed to operate through a wide range of environment, with weight reduced 3 oz., meets shock requirements of MIL-E-5400 and will withstand continuous acceleration of 50 *G* without malfunctioning. Required coil power as low as 20 milliwatts.—*Phaostron Co., 151 Pasadena Ave., So. Pasadena, Calif.*

For more information circle **341** on inquiry card.

Paired Latching Relays

New "Parts No. 9177 and No. 9179" angle-mounted latching relays resist vibration and shock; operate in any

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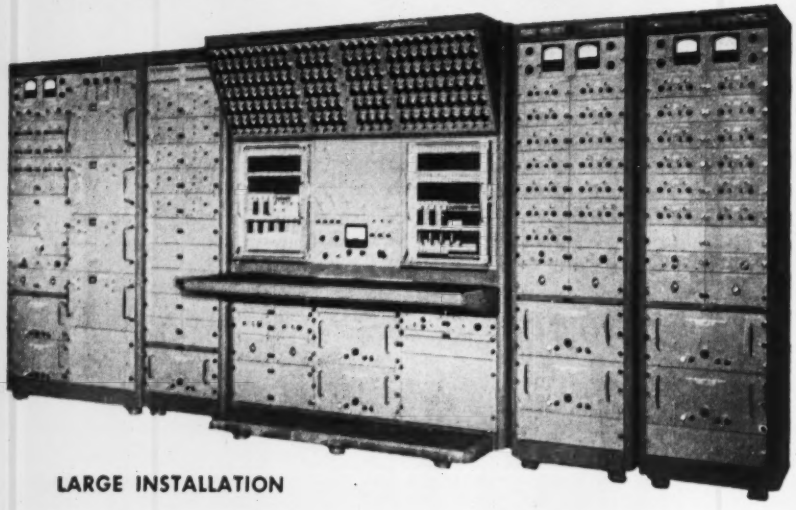
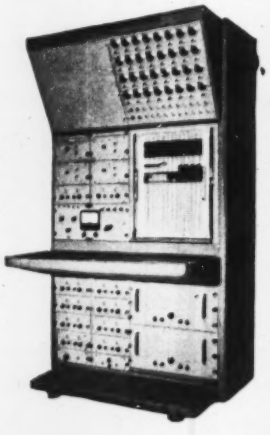


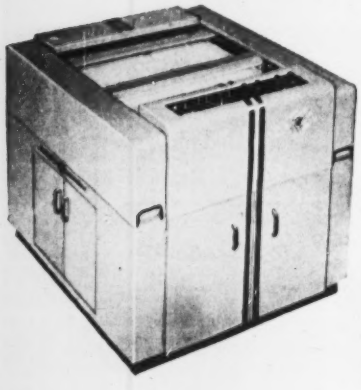
LARGE INSTALLATION

This large computer is used for the rapid solution of aero-dynamic problems. It consists of 50 operational amplifiers, 10 servo multiplying channels, 4 resolving channels, and a control console with two pre-patch bays, 156 attenuators, two voltmeters, and all necessary operational controls

SINGLE PACKAGE COMPUTER

Our Type 16-31R Computer is a single package computer capable of solving differential equations with many simultaneous elements which are often encountered in the simulation of dynamic systems. It contains 20 operational amplifiers, 4 servo multipliers, thirty-two attenuators, all-metal removable problem board, and complete control panel.





PLOTTING EQUIPMENT

For presentation of problem solutions, the Variplotter Plotting Boards provide an accurate inked record. Typical uses include the automatic plotting of: Analog Computer output; guided missile data; engine performance characteristics; and control of manufacturing processes. With accessory equipment the range of applications can be greatly extended.

Write Dept. I

ELECTRONIC ASSOCIATES Incorporated

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For more information circle **86** on inquiry card.

NEW INSTRUMENTS

position; positive latching regardless of wear or play in armature hinge joints. Contact rating: 8 amps. 115 v.ac. non-inductive or 8 amps. 29 v.dc. resistive load.—*Leach Relay Co., 5915 Avalon Blvd., Los Angeles* **3**, *Calif.*

For more information circle **342** on inquiry card.

Hermetically-sealed Relays

New d-c. relay, developed to meet application requirements where space is limited, is hermetically sealed; is

available with 14-pin miniature plug or solder terminals; meets military specs; can be furnished with resistance to shock and vibration and to withstand wide temperature variations. Available for any voltage to 115, d.c. and with contact combinations up to 4-p.d-t.—*Magnecraft Electric Co., 1442-H W. Van Buren St., Chicago 7, Ill.*

For more information circle **343** on inquiry card.

Helium-filled Switch

New hermetically-sealed switch "button" comprises a set of movable contacts in an accordion-like diaphragm enclosure filled with helium gas under pressure; minimizes arcing and pitting; performs at any altitude or where exposed contacts are likely to be affected by dirt and dust and where combustible materials are present. New switch can be produced in any size; lends itself to automatic production techniques.—*Slater Electric & Mfg. Co., Inc., Woodside, N. Y.*

For more information circle **344** on inquiry card.

Heavy-duty Limit Switch

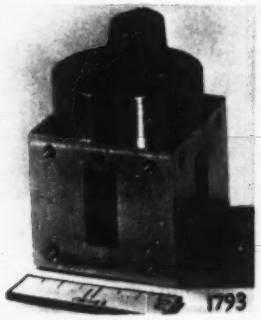
New "Class 9007 Type T" is said to be a highly versatile machine-tool limit switch, featuring easy screwdriver adjustment of basic device to obtain eleven different contact operating sequences. Various operating lever arms are available which can be mounted in any angular position. Approx. 80 deg. of

overtravel is provided in either direction. Neoprene-gasketed die-cast enclosures are watertight, oiltight and dust tight. Seven types of base-plates, as well as threaded holes in side of box, permit mounting in various positions.—*Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.*

For more information circle **345** on inquiry card.

Microwave Switch

New light-weight manually-operated broad-band impedance-matched switch for X band is available in RG-



52/U waveguide size. Input power may be diverted to either of two output channels. Maximum VSWR in switched positions is 1.10 over band 8500 to 9600 Mc.—*General Precision Lab., 63 Bedford Rd., Pleasantville, N. Y.*

For more information circle **346** on inquiry card.

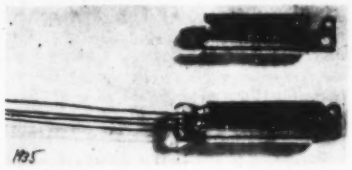
Miniature Toggle Switch

New "Type T622," latest addition to British-made line of electronic-instrument switches using unusually heavy plated beryllium wiping contacts, is a d-p.d-t. quick-make-and-break miniature toggle switch with relatively high current handling ability of 6 amps. on a.c. or d.c. Rated at 3000 v. flash test; uses standard U.S. threads; handle style made to customer's sample or specification.—*British Electronic Sales Co., 23-03 45th Road, Long Island City 1, N. Y.*

For more information circle **347** on inquiry card.

Shield-mount

New "T-2x3 Shieldmount" for type T-2x3 flat press tube envelopes, is fabricated from spring temper phos-



phor bronze; may be obtained silver-plated, blackened or unfinished; may be riveted directly; is provided with a grounding lug where desirable to mount on insulated material.—*National Electrical Machine Shops, Inc., 919 Jesup-Blair Drive, Silver Spring, Maryland.*

For more information circle **348** on inquiry card.

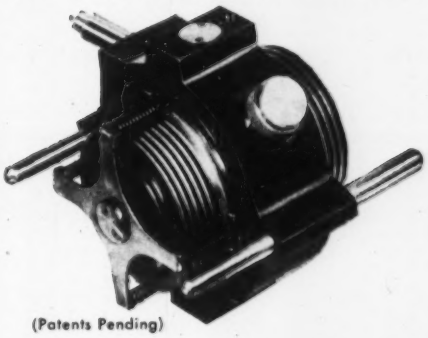
Terminal Block

New "Series R" high-current terminal block will be available in three types: "R" rated 35 amps. 750 v. with screws for wire up to No. 10; "RH" rated 50 amps. 750 v. with solderless connector for wire from No. 8 to No.

IIC®

flow meters

WITH FEATURES THAT MAKE A REAL DIFFERENCE IN SERVICE



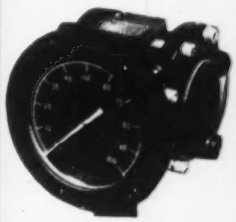
(Patents Pending)

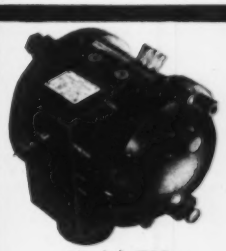
1. Greater power, longer-calibrated travel for assured accuracy.
2. One-piece seamless, type 316 stainless steel bellows. No pitting, no welds, longer life. (Monel bellows can be furnished for special services.)
3. An exclusive I.I.C. development, the patented free floating Non-Freezing Instrument Bearing, makes possible a new era in flow meter accuracy.
4. Differential obtained from actual displacement of fluid and not from stem movement.
5. Over-range protection to housing rating.
6. Pulsation may be dampened in service without special tools.
7. Complete compensation for wide range of ambient temperatures.
8. All standard ranges available: 0-10" H_2O to 0-300" H_2O.
9. Working pressures up to 5,000 psi.
10. No precise leveling required.
11. Self-draining. No seal pots required.

Model 802 Recorder
(Patents Pending)
IIC Model 802 Recording Flow Meter is actuated by Model 700 Meter Unit.
Simple installation. Built by experienced instrument men from a simple design, engineered for rugged duty.

Model 800 Indicator
(Patents Pending)
IIC Model 800 Indicator is actuated by Model 700 Meter Unit, is calibrated in same manner as Model 802 Recorder.

Model 800-6 Indicator
(Patents Pending)
IIC Model 800-6 Indicator is actuated by Model 700 Meter Unit. Standard 6" dials available in uniform, square root, as well as other special ranges.





Model 700 Meter Unit
(Patents Pending)
The new standard of quality for metering devices, the Model 700 Meter Unit is used by other instrument manufacturers to actuate their own differential pressure recorders, indicators, controllers and transmitters.

Write for Bulletin 56-B

IIC®

INDUSTRIAL INSTRUMENT CORP.

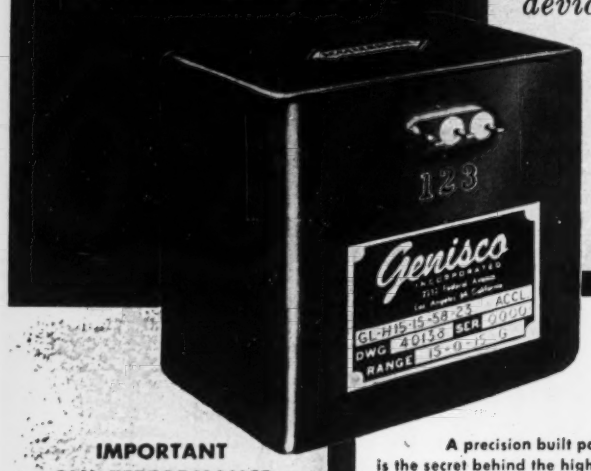
BOX 1909 ODESSA, TEXAS

For more information circle **87** on inquiry card.

Output from this rugged Genisco Accelerometer (GLH MODELS)

is measured in volts ... not millivolts!

minimizes need for amplifying devices!



IMPORTANT GLH PERFORMANCE CHARACTERISTICS

Damping Factor: Instruments up to ±7.5 G's inclusive can be damped .4 to .6 critical; ±7.5 G's to ±10 G incl. .35 to .55 critical; above 10 G's .3 to .5 critical.

Range: ±2 G's to ±30 G's; zero acceleration at midpoint.

Natural Frequencies: 6 to 23 cps. (depending upon range).

Potentiometer Resistance: From 1000 to 10,000.

Resolution: Normally from .25 to .3%, depending upon resistance requirements.

Steady State Acceleration: Can withstand 75 G's in all planes without damage; somewhat less along sensitive axis in low range units.

Linearity: ±0.5% of best straight line through calibration points.

Resistance to shock: 40 G's in any lateral direction; shock loads in 2 directions, equal to range, without damage.

Crosstalk error: Less than 1% change caused by lateral acceleration equivalent to total range of instrument.

Weight: 2 to 2¼ lbs., depending on G range.

Overall Physical Size: 3¼"x3⅛"x 2⅝"

Static Friction: .075 G max. up to and including ±7.5 G's.

0.5% full scale output above ±7.5 G's.

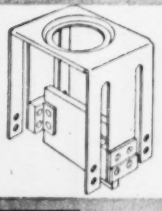
(special modifications for higher natural frequencies and greater damping can be supplied.)

A precision built potentiometer is the secret behind the high output of Genisco's GLH Accelerometer

As much as 50 volts can be put across the potentiometer of the standard GLH, and up to 72 volts on special models. Since the wiper scans the full voltage range, use of the GLH eliminates the need for amplifying devices in many guided missile control and flight test applications.

Keeping the resistance winding free from foreign materials during assembly, careful adjustment of the wiper pressure to precise tolerances, and hermetic sealing of the instrument in inert gas result in electrical output noise so low it can be considered negligible—over a life span in excess of 4 million cycles.

Complete specifications and prices on the GLH are available from Genisco, Inc., 2233 Federal Ave., Los Angeles 64, California. Write today.



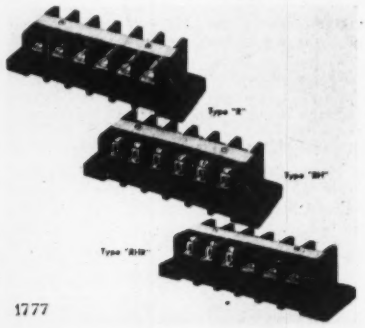
A parallelogram suspension confines the mass of the GLH to a virtual straight line motion and provides excellent lateral rigidity.

Genisco INCORPORATED

Other accelerometer models also available! Write today for information on Genisco's new GMO miniature potentiometer-type accelerometer (weighs only 7 ounces), the new tapped-potentiometer-type accelerometers, and the new DDL Dual-Damped (oil and magnet) accelerometers. Prompt deliveries on all models.

For more information circle **88** on inquiry card.

NEW INSTRUMENTS



1777

18; "RHR" consisting of any combination of "R" and "RH" in same block. White marker strip on top for convenient circuit identification.—*Curtis Development & Mfg. Co., 3266 N. 33rd St., Milwaukee 16, Wis.*

For more information circle **349** on inquiry card.

Three-bladed Power Plug

New "Part #920" armored connector meets all requirements of MIL-C-3767; consists of maker's standard U-120/U armored power plug, to which a removable third blade (for grounding) has been added. Third blade can be purchased individually, for adding to maker's "#921" at a later date, when grounding receptacles will be an electrical standard. This is said to make new unit "an ideal connector for the transitional period between 2- and 3-bladed receptacles." Ratings 125 v. 15 amps. to 250 v. 10 amps.—*Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers 5, N. Y.*

For more information circle **350** on inquiry card.

Connector Covers

New "Series MH-2MI" is answer to requests for a small diameter cover, complete with "Stratoseals," and mounting studs. This type of construction solves many critical problems, such as excessive vibration and sudden temperature changes, without *cracking.—Strat-O-Seal Mfg. Co., 3039 W. Fullerton Ave., Chicago 47, Ill.*

For more information circle **351** on inquiry card.

Custom Hermetic Plugs

New hermetically-sealed plugs which mate with standard "Continental" sockets are available in a large variety. Maker also specializes in analyzing design problems in hermetically-sealed connectors and in manufacturing prototypes for extraordinary applications.—*Electronic Sales Div., De Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **352** on inquiry card.

Hermetic-sealed Connectors

New "Series HVT" miniature hermetic-sealed rectangular connectors feature an all-glass seal fused to each individual contact and to body. In use, "HVT" connector, shaped to serve as a

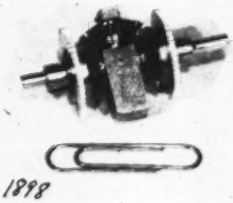
plug, is soldered into top of container which holds component and its wiring: glass seal prevents leakage in gas and fluid-filled units. Especially useful with pressure-type or vacuum-type housings. Mate with standard VT receptacles, are available with 7, 14, 20, and 34 contacts; other contact arrangements on special request.—*Viking Electric*, 1061 *Ingraham St., Los Angeles* 17, *Calif.*

For more information circle **353** on inquiry card.

MECHANICAL COMPONENTS

Computing Differential

New ⅛-in. differential, latest addition to maker's line of single spider-gear differentials, meets military and commercial standards; is made of



1898

stainless steel; weighs less than 1 oz.; performs in a working circle of 1-in. maximum diameter. Breakaway, torque at no-load is 0.01 oz-in.—*Ford Instrument Co.*, 31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

For more information circle **354** on inquiry card.

Miniature Differential

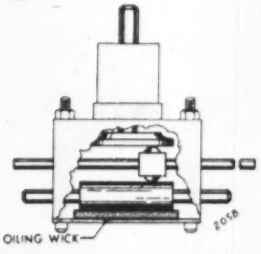
1958

New differential has a max. diam. of 0.937-in.; weighs 1 oz. Differential body and all gears are anodized aluminum: anodized surfaces make gear teeth long-wearing. Input gears may be run at speeds as high as 6000 rpm. and output gear up to 1500 rpm. Maximum backlash 30 minutes. Transmitted torque at output gear may be up to 2 oz.-in.—*Equipment Eng'g Div., Raytheon Mfg. Co.*, 148 *California St., Newton* 58, *Mass.*

For more information circle **355** on inquiry card.

Ball-and-disk Integrator

New ball-and-disk integrator for use in totalizing, rate determination, differential analyzers, or as a closed-



loop mechanical servoelement or precision variable speed drive, has improvements including addition of a permanent lubrication device to increase life, and use of a lubricating

KEARFOTT DEVELOPED VERTICAL GYROS

...in production

KEARFOTT vertical gyros providing continuous vertical reference within two minutes of arc under bench conditions typify the engineering knowhow and production skills available to you in the field of precision gyros for airborne control applications.

Designed for particular applications with stringent performance requirements, a wide variety of vertical gyros now in production are being used extensively in aircraft and missile control systems demanding the most precise gyro reference obtainable.

Kearfott gyros incorporate many unique features permitting operation under extreme operational or environmental conditions. A true hermetic seal in dry inert gas provides positive environmental protection. Synchro pick-offs and rigid structural elements assure performance during adverse conditions of vibration or shock.

TECHNICAL DATA SHEETS

Complete technical data in tabular form on Kearfott Precision Vertical Gyros are available on request. Send for copies for your files. Write today.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Technical Data on these and other components is available on request.

Kearfott SINCE 1917

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West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

A GENERAL PRECISION EQUIPMENT CORPORATION SUBSIDIARY

For more information circle **89** on inquiry card.

Your Spectrophotometer is at its Best when input line is regulated by Sorensen!

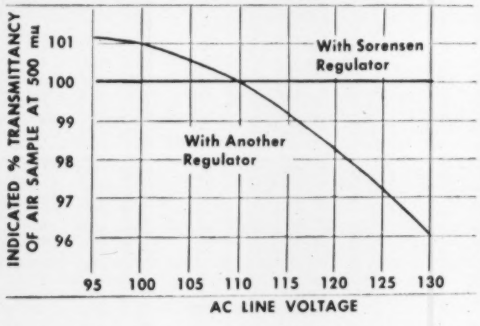
A scientist, working with a spectrophotometer in a government laboratory, recently asked us to cure a condition of instability which was preventing his making accurate or reproducible analyses with the instrument. Despite the use of another type of regulator, line voltage variations were causing random fluctuations of the spectrophotometer meter.

This was readily understandable. The light source of the spectrophotometer was an incandescent lamp, and lamp intensity is an extremely sensitive function of voltage, being expressed by the formula

$$\text{Lamp Intensity} = KE^{3.5}$$

The existing regulator arrangement allowed voltage variations of $\pm 1\%$, resulting in lamp intensity variations of approximately 7%—sufficient to seriously affect readings.

Sorensen's fully satisfactory solution was to replace the other regulator with a Sorensen Model 500S AC Line Regulator. This instrument has a regulation accuracy of $\pm 0.1\%$ with nearly instantaneous recovery time, and effectively eliminated line voltage variations as a source of significant error. A comparison of the spectrophotometer operations under the two input arrangements is plotted below.



With scientists' and technicians' man-hours at a premium, the small investment required to provide a stable input line to power delicate and costly laboratory instruments represents true economy. We invite your inquiry concerning the application of Sorensen electronic power controlling devices to your particular problems. Write directly to Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, correspond directly with Sorensen A. G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

SORENSEN & CO., INC., 375 FAIRFIELD AVE., STAMFORD, CONN.

For more information circle **90** on inquiry card.

NEW INSTRUMENTS

oil which meets military specs. Precision, 0.01 percent. Width, 1⅞"; Length, 2¾"; Height, 3¼"; Weight, 21 oz.—*Librascope, Inc.*, 1607 *Flower Street, Glendale, Calif.*

For more information circle **356** on inquiry card.

Turns-indicating Dial

New "RB Series Duodial" counts the turns of a rotating component to a hundredth of a turn. It comprises two coaxial dials and a black nylon knob integral with inner dial. Inner dial counts hundredths; outer dial complete turns up to fifteen. Knob and inner dial are fastened on shaft of rotating component so that inner dial readings are free from backlash. New "RB Series" can be rotated by either knob or shaft so that it can be used to count power-driven turns as well as to set to a desired value. Available to fit ¼-in. and ⅛-in. shafts.—*Helipot Corp.*, 916 *Meridian Ave., South Pasadena Calif.*

For more information circle **357** on inquiry card.

Hydraulic-hose Assemblies

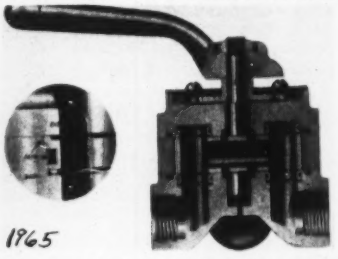
New hydraulic-hose assemblies including couplings, etc., for hydraulic control systems to 5000 psi., are available in all standard sizes. Feature is immediate availability of custom-made assemblies: all are fabricated to user's specs "in a matter of hours."—*Couse & Bolten Co.*, 42 *Lafayette St., Newark 2, N. J.*

For more information circle **358** on inquiry card.

VALVES

High-pressure Valve

New "Lo-Torq" selector valve, for service up to 6000 psi., is said to be truly "balanced." Body, ported as desired, encases a disk having internal flow passages. As the disk is revolved



to produce flow through ports, sealing rings take effect and eliminate cross leakage within valve. Ease of turning: a 6-in. handle is more than adequate for 1-in. size under 6000 psi. pressure. This low turning torque is obtained by unique design based on all-direction hydraulic principle. Sizes ⅜-in. to 1-in. for 0-2000 psi. and ⅛-in. to 1-in. for 0-6000 psi. for most services; for air and gas service, 0-1000 and 0-3000 psi. respectively.—*Republic Mfg. Co.*, 1930 *West 77th St., Cleveland 2, Ohio.*

For more information circle **359** on inquiry card.

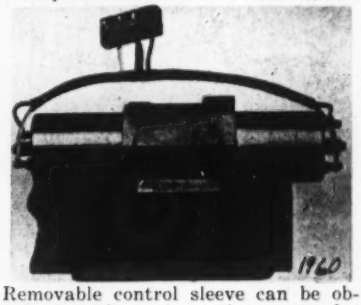
Cylinder-control Valve

New "V5-3 Quick Exhaust" valve is said to increase operating speed of small air and hydraulic cylinders by more than doubling the speed of cylinder return stroke. An ⅛-in. orifice is controlled by utilization of pressure differentials. (Almost all "V5-3" three-way normally-closed valves can now be equipped with this built-in "Quick Exhaust" device.) Other features include stainless steel construction; positive-sealing synthetic inserts; spring-loaded design. "Quick Exhaust" ⅛-in. orifice is supplemented by a 3/32-in. secondary exhaust in all models. Valves are available for complete range of a-c. and d-c. voltages.—*Skinner Electric Valve Div., Skinner Chuck Co., Edgewood Ave., New Britain, Conn.*

For more information circle **360** on inquiry card.

Hydraulic Servo Valve

New high-performance two-stage hydraulic valve has exceptionally small phase shift (2 deg. per cycle per second). It can produce up to 5 hp. at 3000 psi. from small electrical signals.



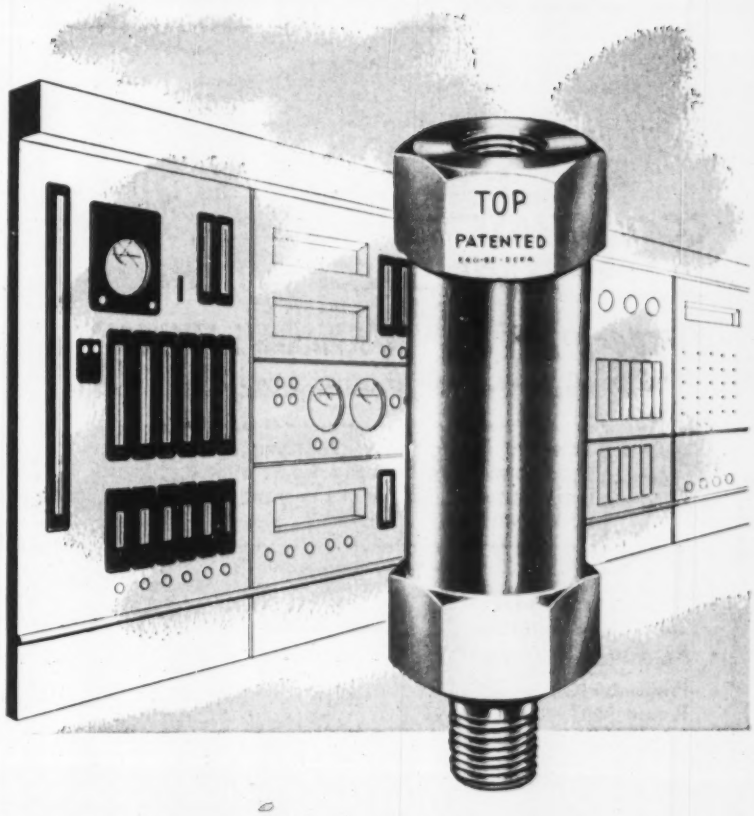
Removable control sleeve can be obtained with various size ports for individual requirements. Valve's inherent design assures freedom from effects of Bernoulli forces at high flow rate.—*Equipment Eng'g Div., Raytheon Mfg. Co., 148 California St., Newton 58, Mass.*

For more information circle **361** on inquiry card.

POWER SUPPLIES

Mag.-amp.-reg. D-c. Supplies

New "Stablvolt Type A" d-c. power supplies, untilizing no vacuum tubes or moving parts, feature dual magnetic regulation which effectively isolates line voltage transients from d-c. output voltage. Response to a-c. line variations of 95 to 135 volts is practically instantaneous with dynamic line regulation better than 0.2 percent. "For the first time . . . a transient-free d-c. power source in the field of d-c. measurement," etc. Stand-



Positive Protection Against Fluid Blow-out...

MERIAM Float Check Valves

Meriam Float Check Valves offer complete assurance that indicating fluid is safely contained in liquid column gauges even though subjected to surges or momentary over-pressuring. These stainless steel units positively prevent fluid blow-out.

Performing equally well with mercury or light indicating fluids, Meriam Float Check Valves close instantaneously when fluid reaches them. They stay closed until the condition is corrected. All the indicating fluid returns to the manometer after pressure is reduced.

Ask your Meriam Instrument Technical Man about Meriam Accessories or write us.

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ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

For more information circle **91** on inquiry card.

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Gaertner TOOLMAKER'S MICROSCOPE

Using Full 2" Precision Screws

This and the following features make the Toolmakers' Microscope an almost indispensable instrument in your shop or laboratory.

Range 2 x 4 inches
360° Stage Rotation
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Stage Motion
By 2 inches
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Column Tilt 8°
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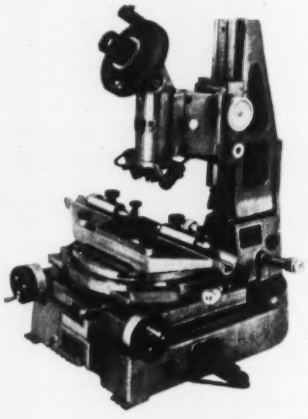

For a completely illustrated book listing detailed specifications and accessories request Bulletin 147-50.

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For more information circle **92** on inquiry card.

TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY

HYDROSTATIC GAUGES

FOR ALL PURPOSES

PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
BAROMETRIC PRESSURE
DIFFERENTIAL PRESSURE
SEND FOR BULLETINS

UEHLING INSTRUMENT CO. 466 GETTY AVE., PATERSON, N. J.

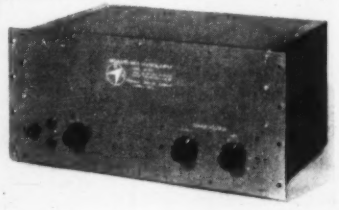
For more information circle **93** on inquiry card.

ard sizes in 6, 12, and 28 volts at current ratings up to 100 amps.—*Magnetic Research Corp.*, 318 *Kansas St., El Segundo, Calif.*

For more information circle **362** on inquiry card.

High-voltage Power Supply

New "Model RE-2002" is a moderately-priced wide-range regulated d-c. power supply. It can be used with klystrons which require extreme sta-

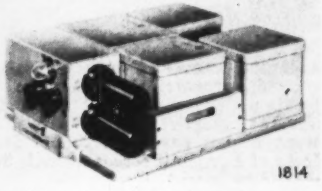


bility and high current capacity. Balanced two-stage high-gain feedback amplifier yields stability ratio of 10^6, internal impedance under 0.5 ohm at d.-c. and ripple under 0.5 mv. peak to peak. Output voltage adjustable from 700 to 2020; output current 0 to 25 ma.—*Northeast Scientific Co.*, 1 *Gray St., Cambridge* 38, *Mass.*

For more information circle **363** on inquiry card.

Miniature Power Supply

New "Type 5206 Miniature Plug-in Power Supply," companion unit to maker's new "5000 Series Miniature

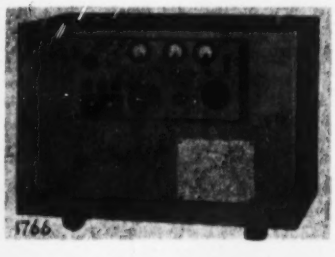


Amplifiers," provides a.c. for amplifier filaments and well-filtered d.c. for plate circuits. A single unit will adequately power 22 "Type 5116" amplifiers or equivalent loads.—*Langevin Mfg. Corp.*, 37 *W. 65th St., New York* 23, *N. Y.*

For more information circle **364** on inquiry card.

D-c. Power Supply

New mobile battery power supply and selenium rectifier taper charger consolidated into a single unit provide d-c. power from 2 to 30 volts and adjustable and metered charging. Unit incorporates required facilities for both laboratory and production testing of electrical equipment in accord-



ance with rigid military specifications; also has uses in educational institutions. Input circuit protection is provided by a circuit breaker and fuses. —*Bart-Messing Corp.*, 229 *Main St., Belleville, N. J.*

For more information circle **365** on inquiry card.

AMPLIFIERS

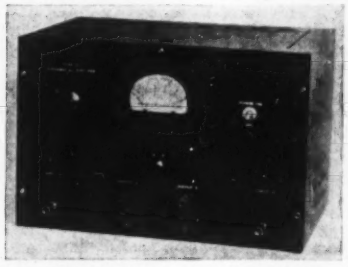
Magnetic Amplifiers

New line of magnetic amplifiers consists initially of three types: (1) high-temperature, operating in ambients to 200 C. (392 F.) with characteristic times as low as 0.003 sec.; (2) half-cycle-response units operating in ambients from −55 C. to 70 C.; (3) full-wave units using self-saturating or external feedback circuitry. —*Freed Transformer Co.*, 1715 *Weirfield St., Brooklyn* 27, *N. Y.*

For more information circle **366** on inquiry card.

Differential Amplifier

New "Type 501 Duo-channel Differential Amplifier" is a wide-band amplifier which will convert a differential



signal into a single-ended signal. Each of two identical channels has a high differential ratio amplifier stage and a balance-to-unbalance converter with no transformer. Ratio of amplification for differential signals to that of common-mode signals is over 38×10^6 from 8 cps. to over 500 kc.—*Advance Electronics Co., Inc.*, 451 *Highland Ave., Passaic, N. J.*

For more information circle **367** on inquiry card.

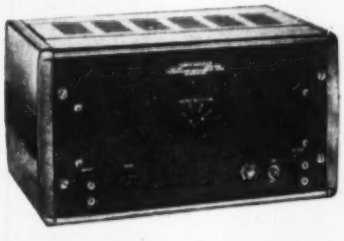
TV Distribution Amplifier

New "VDA 100" video distribution amplifier comes complete with power supply; features 6 complete amplifier strips (instead of usual 5) each easily plugged in or out for servicing.—*Eastern Precision Resistor Corp.*, 130-11 *90th Ave., Richmond Hill* 18, *L. I., N. Y.*

For more information circle **368** on inquiry card.

Laboratory Amplifier

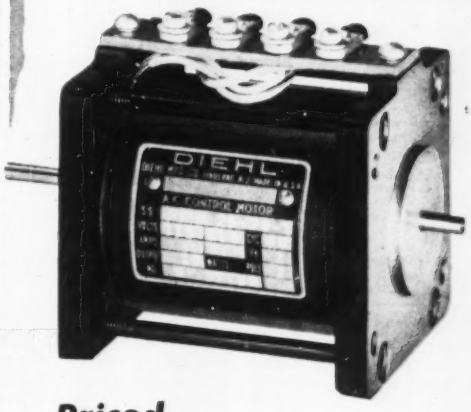
New "Type 511A Power Amplifier" is a general-purpose laboratory power amplifier, said to feature low distortion, low noise, and excellent phase



Servo Motors meeting JAN environmental requirements need not be expensive!

DIEHL

"HI-AC-CEL" Low Inertia A. C. Servo Motors



SPECIFICATIONS:

Diehl Number: FPE 25-79-1

10 Watts Maximum Output

115 Volts Main Phase

115 Volts Control Phase

2 Poles

2 Phase

12.5 oz.-in. Locked Torque

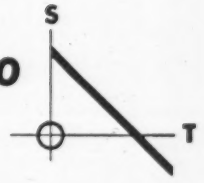
23.0 oz.-in. Torque at minus 3000 R.P.M.

.125 oz.-in.^{2} Moment of Inertia

1.6 lbs. in Weight

38,600 Radians per Second^2 Theoretical Acceleration

Priced at only $30.00



This newly designed Diehl "HI-AC-CEL" Servo Motor affords high response and is suitable for a broad range of military and industrial servo-mechanism applications.

FEATURES:

1. Cogging (Slot effect) is Negligible
2. No Single-Phasing
3. Speed-Torque curve extends into the negative speed range at approximately the same slope.

Diehl "HI-AC-CEL" Servo Motors are obtainable in ratings from 5 to 25 watts output with standard 115 volt control phase windings and also with high impedance control phase windings. All ratings can be furnished with either A.C. or D.C. integrally mounted tachometer generators.

Our wealth of experience in producing quality motors is at your service to help you select the unit best suited to your specific requirements. Copy of Technical Manual No. IN-0554 describing Diehl Servo Motors and related equipment is yours for the asking.

Other Available Components:
D.C. SERVO SETS • RESOLVERS
MINIATURE PERMANENT MAGNET D.C. MOTORS

Diehl

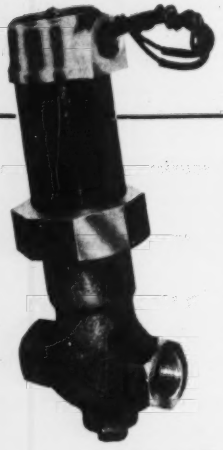
DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING CO.
Finderne Plant, SOMERVILLE, N. J.
Atlanta Baltimore Boston Chicago Detroit New York Philadelphia Worcester

For more information circle **94** on inquiry card.

NEW! Atkomatic

SOLENOID

Cast Iron and Cast Steel Valves



ATKOMATIC'S new line of cast iron and cast steel valves offer greater range of applications as well as new engineering principles. Internal design features compensate for expansion under heat, prevent sticking. Stainless steel hooded pilot seat screw permits more positive closing action. New design permits pressures to 1000 P.S.I. at 200° F., 500 P.S.I. at 450° F. Teflon disks inert to all media except hot fluorine are used. Removable inserts are used throughout complete range of sizes.

Available in sizes ½ through 2 inches.

Write for Technical Bulletin No. 106 for more complete information

Atkomatic

SOLENOID

ELECTRIC VALVES

ATKOMATIC VALVE COMPANY

525 ABBOTT STREET INDIANAPOLIS 25, INDIANA

For more information circle **95** on inquiry card.

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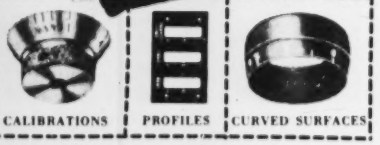
in your own shop

Lowest set-up time for unskilled labor



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10,000 in use. The speediest, most versatile portable engraver. Only the NEW HERMES has these features:

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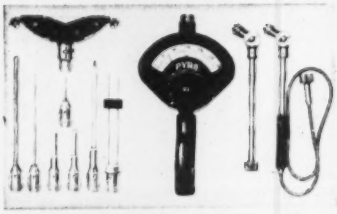
For more information circle **96** on inquiry card.



THE NEW

PYRO

Surface Pyrometer

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PYROMETER INSTRUMENT COMPANY

Bergenfield 4, New Jersey

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The NEW PYRO Surface Pyrometer has been designed to meet all plant and laboratory surface and sub-surface temperature measurements. Has large selection of thermocouples and extension arms — all interchangeable without adjustment. Quick acting, accurate, light-weight and rugged. It features a large 4¾" direct reading scale, automatic cold end junction compensator and a shielded steel housing—all combined to offer the highest precision, accuracy, dependability and durability. Available in five standard temperature ranges from 0-300°F to 0-1200°F.

Literature also available FREE on PYRO Optical, Indicating, Radiation and Immersion Pyrometers.

Ask for Catalog No. 168 for full details.

For more information circle **97** on inquiry card.

NEW INSTRUMENTS

characteristics throughout audiofrequency range and above. Choice of four output levels for optimum matching of various loads. Will operate into loads of complex impedance from pure resistance to pure reactance and will drive a 1200-ohm load with 120 volts at 0.5 percent harmonic distortion. Input impedance is equivalent of 100,000 ohms shunted by 10 uuf.—*Technology Instrument Corp., 531 Main St., Acton, Mass.*

For more information circle **369** on inquiry card.

MISCELLANEOUS

Metal Detector

New model of maker's "Electronic Metal Detector" for continuous inspection of textiles features a narrow inspection aperture, available in a wide range of widths. It indicates presence of magnetic and non-magnetic, ferrous and non-ferrous, metals, in materials moving at speeds of 25 to 1000 fpm. Controls of new model can be set to stop a conveyor, light a warning light, sound a horn, spray-mark contaminated area, or perform any combination of these functions.—*Industrial Products Section, Radio Corp. of America, Front & Cooper Sts., Camden, N. J.*

For more information circle **370** on inquiry card.

Tape Typewriter

New "Unityper II" erases all previously recorded information prior to recording current data, records new data in code on tape, and simultaneously prints a proof-copy. Errors on

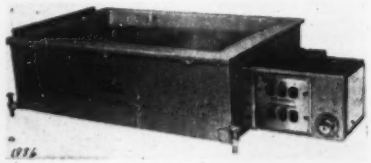
1964

tape, either one character or a whole line at a time, can be erased. Announcement emphasizes that new instrument is "much more than a simple transcription device." Various extra control circuits aid in producing accurate tape recordings.—*Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.*

For more information circle **371** on inquiry card.

Graphic-circuit Solder-pot

New 2000-watt solder pot for graphic circuit work features an adjustable calibrated hydraulic thermostat with seven steps of fixed temperatures and three values of load wattages. Cavity dimensions 20 x 12



1964

in. with usable depth of 1½ in. (actual 2 in.) A calibration chart is furnished so that when desired operating temperature is known, switches may be correctly set without measurement. Maximum temperature 550 F.—*Dee Electric Co.*, 1101 *N. Paulina St., Chicago* 22, *Ill.*

For more information circle **372** on inquiry card.

Soldering Set

New "Model 101 Solder-Quik," for fast soldering on small work, operates from 110-v.ac. line through a step-

down transformer, has six heat ranges. Soldering heat is obtained at tip by passing low-voltage current through a small area of the work by means of two long-life carbon electrodes.—*Stark Mfg. Co., P.O. Box* 489, *Tuscaloosa, Ala.*

For more information circle **373** on inquiry card.

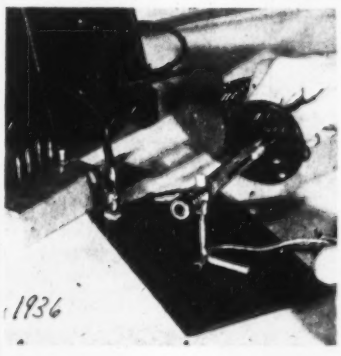
Silver-brazing Flux

New "No. 110" homogenized uniform-action flux, said to overcome many complex problems in production assembly, is compounded specifically for work on stainless steel, nickel, Monel, copper, berryllium-copper, brass, bronze, steel, and silver metals. Mixed with plain water by user and brushed on work, it protects heated base metal up to 1800 F. and dissolves oxides that must be carried away before a good joint can be made.—*All-State Welding Alloys Co., Inc.*, 249-55 *Ferris Ave., White Plains, N. Y.*

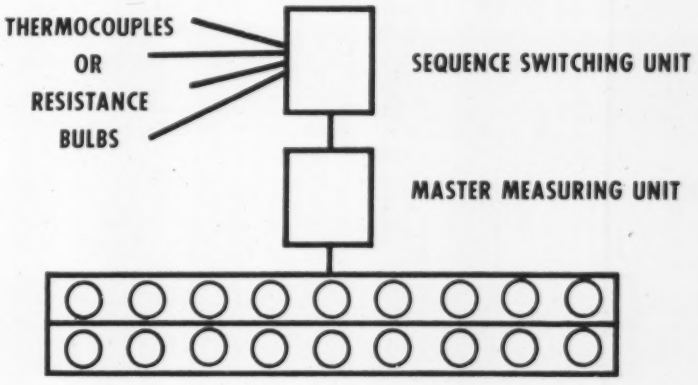
For more information circle **374** on inquiry card.

Spot Solderer

New "Newage Lorsol Electric Spot Solderer" has carbon tip operating on low voltage supplied through transformer which gives concentrated heat when tool contacts work and shuts off when contact is broken. Synthetic insulating handle has end formed as a shield; is shockproof. Transformer gives six different heats. "Newage Lorsol" can be fitted with two carbon tips at angles in addition



Thermo Electric's SignaLarm is a temperature monitoring system composed of well-tested, standardized units. Each SignaLarm system consists of 4 basic parts:



SIGNAL LAMPS

The signal lamps indicate the condition at each measuring point as it is scanned. The master measuring unit can be pre-set easily to operate signal lamps at the high or low point you want. If the temperature is normal, a green light flashes—but if the temperature passes the danger-point you set, a red light goes on and an audible alarm is sounded. The alarm can be silenced by pressing a button, but the red light stays on until temperature returns to normal.

Different temperature monitoring systems can be built-up from standard SignaLarm units. Each SignaLarm can handle up to several hundred thermocouples (or resistance bulbs). Additional systems can be installed for greater capacity, or for high-speed scanning, or for monitoring various temperature points independently of one another.

Interested? Write for Bulletin 70—F.

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

For more information circle **98** on inquiry card.

New! KELLOGG

CROSSBAR SWITCH
for Automatic
Control Systems and Computers

FAST!

LOW INITIAL COST!

MANY CIRCUIT APPLICATIONS!

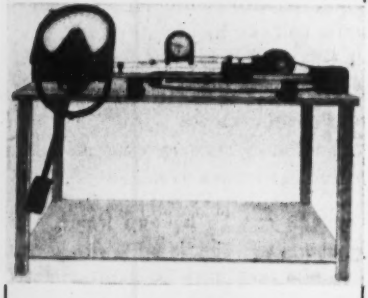
Kellogg Crossbar Switch provides the fast, low-cost means of interconnecting or selecting many different circuits common to large-scale switching required by automatic control systems or computers. Its many applications include, for example, connecting any 3 of 60 circuits to any of 75—or choosing 1 circuit from as many as 936. It provides circuit connections in 50 milliseconds by energizing two specific coils. For optimum fidelity of signal and prevention of corrosion, palladium contact points are used. Mounted for drawerlike removal from its rack. Get the complete facts — Write Dept. 61-E today.

KELLOGG DIVISION OF IT&T

KELLOGG SWITCHBOARD AND SUPPLY COMPANY
A Division of International Telephone and Telegraph Corporation
SALES OFFICES: 79 W. Monroe Street, Chicago 3, Illinois

For more information circle **99** on inquiry card.

AMTHOR
TENSILE STRENGTH
TESTERS



type 274
for VERY LIGHT MATERIALS
Horizontal type—Bench Model

Various ranges up to maximum of 25 lbs.
With or without elongation indicator.

Write for bulletin 129

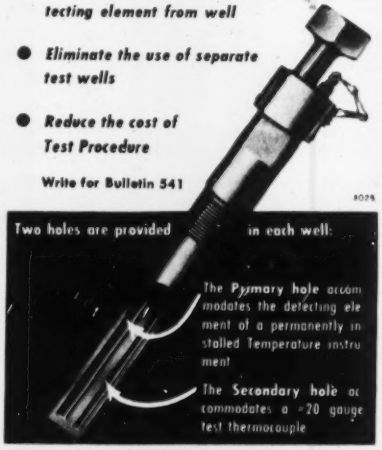
AMTHOR
TESTING INSTRUMENT CO., INC.
48 Van Sinderen Ave., Brooklyn, N. Y.

For more information circle **100** on inquiry card.

TRINITY
DOUBLE-BORE
THERMOWELLS

- *Minimize the factors of error in Temperature Instrument Test Procedures*
- *Permit accurate test without removing detecting element from well*
- *Eliminate the use of separate test wells*
- *Reduce the cost of Test Procedure*

Write for Bulletin 541


Two holes are provided in each well:
The Primary hole accommodates the detecting element of a permanently installed Temperature instrument
The Secondary hole accommodates a #20 gauge test thermocouple

TRINITY EQUIPMENT CORPORATION
486 Westfield Ave., East • Roselle Park, New Jersey
MANUFACTURERS OF
THERMOWELLS, HEAT FLOW INDICATORS AND OTHER PROBES, EQUIPMENT

For more information circle **101** on inquiry card.

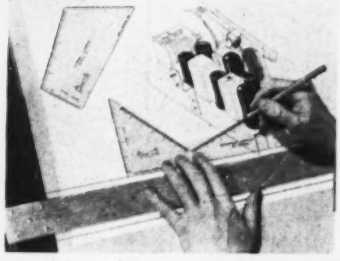
NEW INSTRUMENTS

to end fitting. Carbon tips can be machined to any shape to facilitate unusual work; can be used simultaneously. Carbons are supplied in 3/16, ¼ and 5/16 in. diameters.—*Newage International, Inc.*, 235 *E. 42nd St., New York* 17, *N.Y.*

For more information circle **375** on inquiry card.

Draftsman's Templates

New five-piece template set for use in technical illustration work provides a uniform system for determining dimensions of lines and angles in

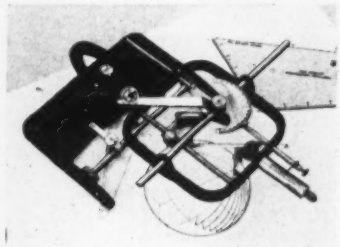


pictorial drawing. Even curves, radii, and ellipses are determined. Templates enable draftsmen to draw views of an object from any angle. Their use is quickly grasped.—*Charles Bruning Co.*, 4700 *Montrose Ave., Chicago* 41, *Ill.*

For more information circle **376** on inquiry card.

Circular Drawing Machine

New drawing machine is said to enable technical illustrators and draftsmen to make accurate pictorial drawings in less time than it takes



to make plan view drawings. Two simple settings—to establish major and minor diameters—enable user to draw ellipses in any ratio by degrees or from points on a drawing. Instrument's "rolling parallel action" makes it especially valuable for use in making exploded views.—*Charles Bruning Co.*, 4700 *Montrose Ave., Chicago* 41, *Ill.*

For more information circle **377** on inquiry card.

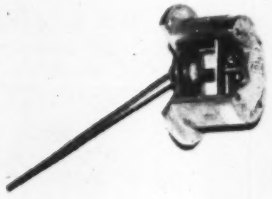
Noise Suppressor

New "Type 114-A Dynaural Noise Suppressor" virtually eliminates turntable rumble and record scratch or hiss without losing music audible to ear as do fixed filters; is designed as an accessory unit for use with maker's "99 Transcription Amplifier." or "214 Remote Control Amplifier." Frequency response flat from 19 to 20,000 cps.—*H. H. Scott*, 385 *Putnam Ave., Cambridge* 39, *Mass.*

For more information circle **378** on inquiry card.

Dry-material Level Controller

New "Scrayco Level Control" controls dry material by utilizing a principle which is reverse of ball float: its shutoff device goes down,



instead of up. A rod running through a flexible sphere bends downward inside bin (or duct or chute); may be angled to any degree. This "sensing probe" comes into contact with the flowing material and actuates a switch that cuts off flow at desired level.—*Scrayco, Inc.*, 201 *Greene Ave., Bound Brook, N. J.*

For more information circle **379** on inquiry card.

Instrument Oiler

New "Pell-i-can," pen-sized oiler with a long narrow "beak," now makes it easy to fill small out-of-the-way oil holes in small apparatus; is easy to refill and unbreakable in normal use; features a visible oil supply and pocket clip; avoids spilling by delivering oil one drop at a time.—*The Lofthouse Co., Box* 832, *Binghamton, N. Y.*

For more information circle **380** on inquiry card.

Steam Trap

New "Heat-Kwik Super-Silvertop" steam trap is reported to vent air out of steam-consuming units "eight times faster than ordinary inverted-bucket traps and three times faster than air-eliminator or blast type traps." It has two separate orifices, one for condensate and a separate bellows orifice for air. When trap is cold, bellows orifice is wide open and handles large quantities of air. After all air is removed through vent hole in bucket. Sizes from ¾ in. 1¼ in.; pressures up to 150 psi.—*The V. D. Anderson Co.*, 1935 *W. 96th St., Cleveland* 2, *Ohio.*

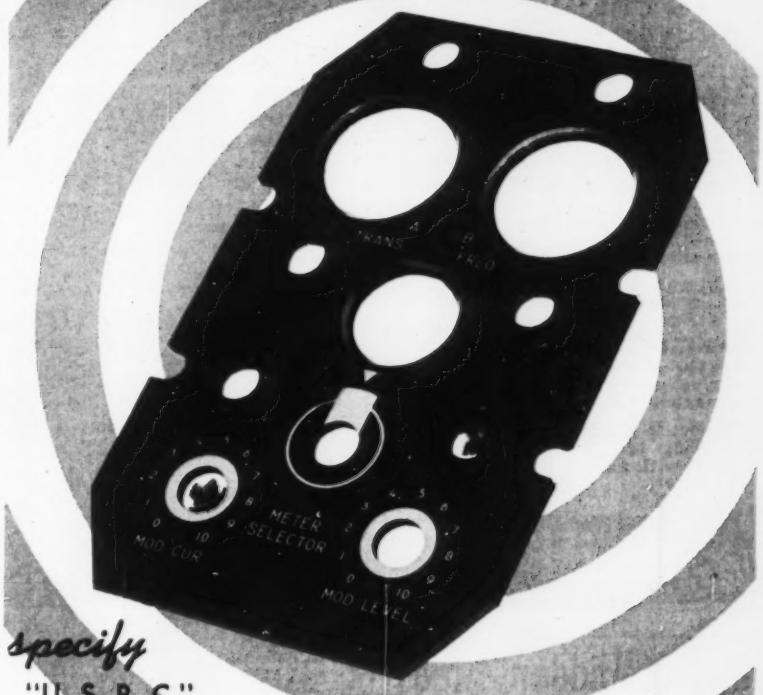
For more information circle **381** on inquiry card.

Anti-static Cleaning Agent for Lucite and Plexiglas

New "ANSTAC-2M" is announced as "believed to be the most effective and long lasting anti-static and cleaning solution available today." It is relatively fast drying and may be applied by dipping, spraying or wetting article with a cloth dampened in the solution. "Only a microscopic amount is necessary." It does not de-

FOR THE MAXIMUM IN

LEGIBILITY



specify

"U. S. R. C."

EDGE-LIGHTED PANELS

meet all requirements of specifications MIL-P-7788 and AN-P-89

Produced by the "Lackon" process, the photographic reproduction method which incorporates the better features of all other panel and dial processing methods. The "Lackon" process combines simplicity, flexibility, adaptability, reproducibility, accuracy and economy.

Regardless of whether your interest is in general appearance, uniformity of lighting, legibility, wear or weather resistance, long life or economy — it will be to your advantage to investigate the best.

May we furnish additional information and make available our engineering and lighting experience?

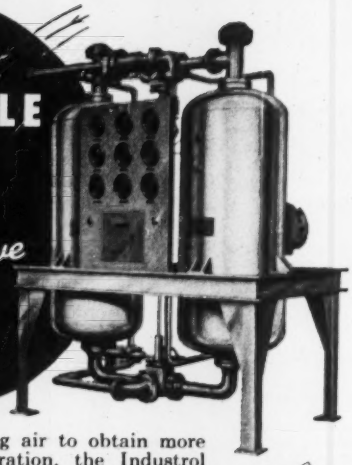
Write Dept. 1-5

UNITED STATES RADIUM CORPORATION
535 Pearl St. New York 7, N. Y.

US RADIUM

For more information circle **102** on inquiry card.

for DEPENDABLE Instrument Operation You Must Have CLEAN-DRY AIR



When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.

An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.

Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.

Send for Bulletin DD-150

2366

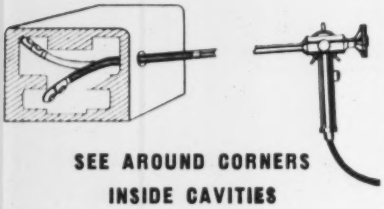
Industrol CORPORATION

SUBSIDIARY OF TRINITY EQUIPMENT CORPORATION

494 Westfield Ave., East • Roselle Park, New Jersey

For more information circle **103** on inquiry card.

Inspect Hidden Areas



SEE AROUND CORNERS INSIDE CAVITIES

The Eder Flexible Inspectroscope, designed like a doctor's gastroscope for stomach examination, lets inspectors view inside cavities with small openings. Sizes from 3" to over 15 feet long can be used. Right angle and forward viewing combination scopes inspect inside gun barrels or tubes. Special instruments can be designed for your particular inspection problem.

WRITE FOR ILLUSTRATED FOLDER

EDER INSTRUMENT CO.

2293 N. Clybourn, Chicago 14, Ill.

For more information circle **104** on inquiry card.

Fine PRESSURE GAGES . . .

—are the result of good design, careful selection of materials and meticulous care in manufacturing.

In the Acragage you get these three vital factors plus the famous solid front with full area blow out disc.

Catalog M-50 tells much about these better Acragages.

Send for your copy today.

The ACRAGAGE Corporation

WAMPUS LANE • MILFORD, CONN.

For more information circle **105** on inquiry card.

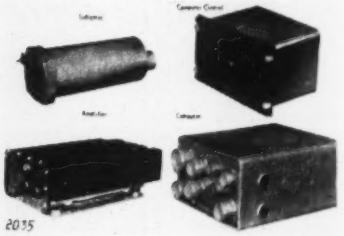
NEW INSTRUMENTS

pend on moisture for its effectiveness. It prevents troubles caused by static, such as electrical instrument lenses sufficiently charged to cause errors in readings.—*Chemical Development Corp., Danvers, Mass.*

For more information circle **382** on inquiry card.

Ground-position Indicator

New "Computer Set, Latitude and Longitude AN/ASN-6" is a dead-reckoning computer which automatically gives a pilot his latitude and



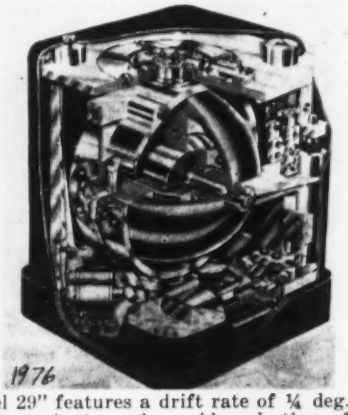
2035

longitude in flight without any air-to-ground or ground-to-air communication. It consists of Indicator, Computer Control, Amplifier, and Computer, entire navigational system weighing 45 lbs.—*Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.*

For more information circle **383** on inquiry card.

Free Gyro

New "Model 29 Free Gyro" operates on 28 v.dc.; has a single axis potential-divider pickoff; is suitable for application in telemetering or control of aircraft, guided missiles, etc. "Model 29" features a drift rate of ¼ deg. per minute and a wide selection of potential dividers with resistance values from 1000 to 100,000 ohms and standard linearity tolerance of 0.25 percent. Caging time depends upon alignment of gimbals, varying between 1/10 and 300 seconds.—*Summers Gyroscope Co., Santa Monica, Calif.*



1976

For more information circle **384** on inquiry card.

Magnetizer

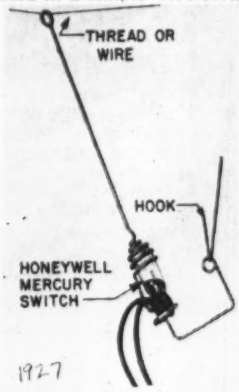
New "Model 8100" impulse magnetizer has been developed to magnetize shapes that cannot be processed with an electromagnet, including those in which reluctance of air at open end is less than reluctance of magnetic material, as well as completely closed circuits. Equipment is unique in that it is exceptionally economical of power: requirement is 220/440 v. 32/16

amp. (max.), 60 cps. single phase. Unique control circuit stabilizes voltage instantaneously.—*Equipment Sales Div., Raytheon Mfg. Co., Waltham* 54, *Mass.*

For more information circle **385** on inquiry card.

Thread-break Detector

New thread break detector comprises a Honeywell mercury switch assembled in a simple wire-form actu-



ator with "eyes" on its ends, for attaching to thread and for supporting on a pivot. Two wire forms are provided, so that mercury switch can be held in an open or closed position.—*Micro Switch, Freeport, Illinois.*

For more information circle **386** on inquiry card.

Railroad Track Scales

New "Four-Section Straight Lever Railroad Track Scale" is added to maker's line, making it "the most complete," with 25 standard models, capacities ranging from 60 to 200 tons per section, various sizes and lengths. —*The Howe Scale Co., Rutland, Vermont.*

For more information circle **387** on inquiry card.

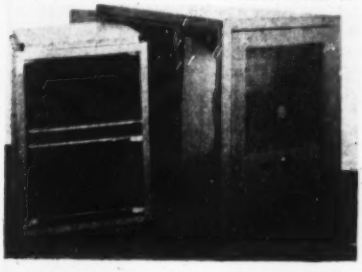
Pipe Thread Compound

New "Flexrock 25 Teflon Pipe Dope" is a thread-sealing compound said to have excellent lubricating qualities to prevent galled threads and permit easy pipe joining that can be readily dismantled after long exposure to rigorous conditions. Successful tests on lines conveying strong acids, alkalies, and solvents, at temperatures from —150 F. to 500 F. Biologically inert. At present furnished in 4-oz. cans for test purposes.—*Flexrock Co., Packing Div., Philadelphia* 1, *Pa.*

For more information circle **388** on inquiry card.

Space Cleaner

New "Sterilshield Space Cleaner" lowers dust, smoke, pollen, or bacteria content of air; makes use of a 1000-cfm. electrostatic air cleaner with its



STANDARD

Radio Interference and Field Intensity

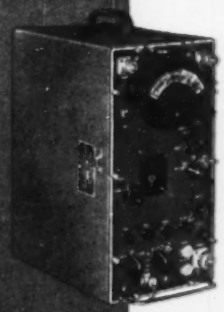
MEASURING EQUIPMENT

Complete Frequency Coverage—14kc to 1000 mc!

NM-10A

VLF

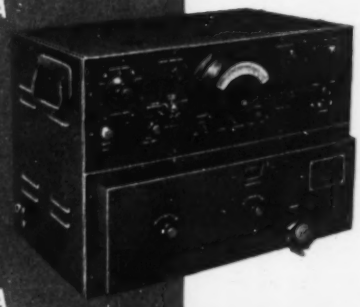
14kc to 250kc
Commercial Equivalent of AN/URM-6B.
Very low frequencies.



NM-20B

HF

150kc to 25mc
Commercial Equivalent of AN/PRM-1A. Self-contained batteries. A.C. supply optional. Includes standard broadcast band, radio range, WWV, and communications frequencies.



NMA-5A

VHF

15mc to 400mc
Commercial Equivalent of TS-587/U.
Frequency range includes FM and TV Bands.

NM-50A

UHF

375mc to 1000mc
Commercial Equivalent of AN/URM-17.
Frequency range includes Citizens Band and UHF color TV Band.

These instruments comply with test equipment requirements of such radio interference specifications as MIL-I-6181, MIL-I-16910, PRO-MIL-STD-225, ASA C63.2, 16E4, AN-I-24a, AN-I-42, AN-I-27a, MIL-I-6722 and others.

STODDART AIRCRAFT RADIO Co., Inc.

6644-D Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

For more information circle **106** on inquiry card.

associated power supply; and a propeller fan to drive air through the unit. Dust collector cell can be easily removed and cleaned by running water. Dimensions 33x32x21 in.—*The Baker Co., Inc., Maplewood, Maine.*

For more information circle **389** on inquiry card.

Sprinkler-control System

New "No. 550 Sprinkler Control," for use with any concealed irrigation system, makes lawns, gardens and orchards thrive on regular irrigation "without your touching a hose or

valve all summer long." It turns sprinklers on and off according to predetermined time schedules, except when rainfall has sufficed for moisture needs of soil. Feature is "Zubastat" detecting assembly of electrodes in a cup which holds a representative sample of one soil area. From one to twelve areas may thus be controlled, each with its dial on indoor panel and "Zubastat" outdoors.—*Tork Clock Co., Inc., Mount Vernon, N. Y.*

For more information circle **390** on inquiry card.

Indicating Fuse Post

New "No. 344010" indicating fuse post, said to be smallest on market, is designed for 3 AG and 3 AB fuses in ratings up to 15 amps. and 250 v.

maximum; provides positive indication, 360 deg. from any point. Waterproofing to Signal Corps specs if requested—*Littelfuse, Inc., Des Plaines, Ill.*

For more information circle **391** on inquiry card.

Heat-resistant Magnet Wire

New silicone-enameled magnet wire is intended for use in electrical equipment operating at "hottest spot" temperatures of 130 C. (266 F.) or more. Enamel has good abrasion resistance; adheres well to conductor; is smooth, will not craze when exposed to solvents, and will not crack when subjected to extremely low temperatures (–65 C.); dielectric strength 1500 volts per mil.—*Anaconda Wire & Cable Co., Muskegon, Mich.*

For more information circle **392** on inquiry card.

Heat-resistant Lead Wire

New "Tempclad" glass-braided lead wire for components operating at temperatures from –55 C. to 200 C. (392 F.) has primary conductor insulation of Teflon which "exhibits excellent dielectric strength, low power factor, high insulation resistance and low dielectric constant; remains unaffected by temperature cycling, and is inert to all known commercial solvents." Secondary insulation, of Teflon-impregnated glass braid, resists abrasion. Sizes 28 AWG to 10 AWG; eight solid colors; special tracer colors available.—*Hitemp Wires Inc., 26 Windsor Ave., Mineola, L. I., N. Y.*

For more information circle **393** on inquiry card.

Illuminated Magnifiers

New and complete redesign of housing for "Flash-O-Lens" illuminated magnifiers features a new type of thumb-nail-notch grip which facili-

tates loosening and tightening ring that holds lenses; is molded of heat-resistant polystyrene.—*E. W. Pike and Co., Inc., 492 North Avenue, Elizabeth, N. J.*

For more information circle **394** on inquiry card.

Electric Pen

New "Actograp" electric pen has magnetic vibrating system whereby a short continuous arc is produced which performs engraving on all metals including hardest tempered or case-hardened steel, tungsten carbide, etc. Marks can only be removed by

100 PAGE
NEW CATALOG
CONTINUOUS DUTY
DIAPHRAGM SEALS

CHANGE INSTRUMENTS
UNDER PRESSURE

AN
INNOVATION
FOR
CHEMICAL SERVICE

MANSFIELD & GREEN
1051 Power Ave. Cleveland 14, Ohio

For more information circle **107** on inquiry card.

—for
"INSTRUMENT-QUALITY"
AIR
IN COMPRESSED AIR OPERATIONS...

HERE'S YOUR ANSWER!

HANKISON
MODEL B-30-D
Condensifilter

Featuring the New-Economical
DISPOSABLE FILTER CARTRIDGE

Dehydrate and filter ordinary plant air with a Hankison Model B-30-D Condensifilter for air of "Instrument-Quality." Condenser section removes moisture by lowering dew point of air to within 2 or 3 degrees of cooling water; low cost, disposable filter cartridge with 540 sq. in. of surface area removes even finest dirt particles. Capacity: 30 scfm at 100 psig.

Write for Bulletin B-30-D
For larger capacities, write for data on Model A-100.

HANKISON CORPORATION
354 Biltmore Building, 951 Banksville Road
PITTSBURGH 16, PENNA.

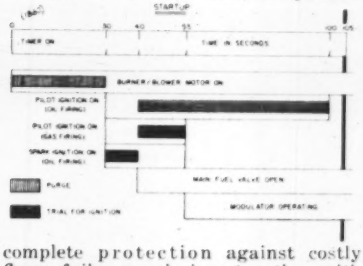
For more information circle **108** on inquiry card.

grinding, filing or destroying article. Hardness is immaterial as penetration is sufficient to give depth of marking required at point of contact, leaving a clear line. Screw adjustment at tip enables operator to scribe thick or thin lines, as well as adjusting depth of engraving. Transformer is specially designed for pen.—*Newage International, Inc.*, 235 *E. 42 St., New York, N. Y.*

For more information circle **395** on inquiry card.

Burner Program Control

New "Fireye Programming Control" for commercial-industrial gas, oil, or combination gas/oil burners, is said to be "the first to provide

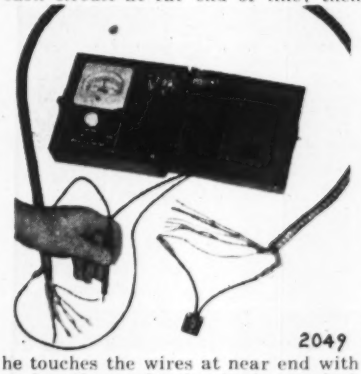


complete protection against costly flame failure explosions together with programming to meet any application requirement." Standard "package" provides complete automatic startup, operating, and shutdown control for any type of burner and a selection of programming times for three types of ignition operation to comply with Factory Mutual Labs' requirements. (Diagram shows automatized sequence for start-up only; other positions of complete sequence omitted for lack of space.)—*Combustion Control Corp.*, 718 *Beacon St., Boston* 15, *Mass.*

For more information circle **396** on inquiry card.

Cable-conductor Tracer

New "Trace-O-Meter" makes it possible for one man instead of two to trace electrical lines and cable circuits: he slips a tagged jumper to each circuit at far end of line; then

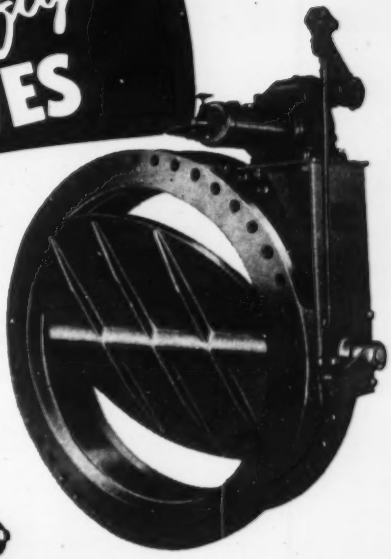


he touches the wires at near end with probe. As each circuit is touched, meter indicates the correct number as tagged by the jumper. Thus nine wires can be identified. (If more, they can be identified and marked in groups or nine.) If there is any doubt about a line being hot, it is tested with neon indicator. Should there be a ground or short in a wire, pointer will not move.—*The Jackson Electrical Instrument Co.*, 20-48 *S. Patterson Blvd., Dayton* 2, *Ohio.*

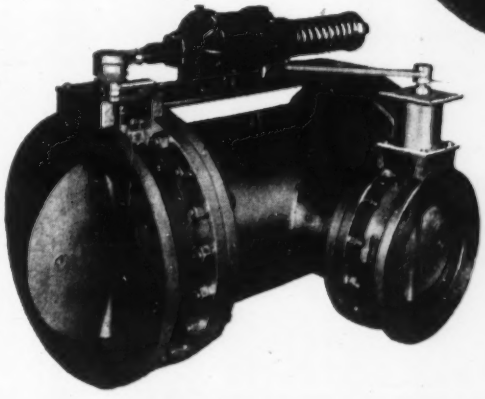
For more information circle **397** on inquiry card.

Get Positive Control and Safety

with W. S. ROCKWELL Butterfly VALVES



A 54" cast iron butterfly valve with stainless steel blade for low pressure air; equipped with crank type cylinder operator; installed in public utility plant.



Three-way valve made with 24" and 14" butterfly valves mounted on a "tee"; linked so as to close one valve when the other opens; operated by spring-loaded hydraulic cylinder; for air and exhaust gases to 60 p.s.i. and 350° F.

Rockwell Butterfly Valves are made of any required metal or rubber-lined for minimum pressure drop, uniform, quick control and positive shut-off—commercial, drip or air-tight. Sizes to 132"; pressures to 900 p.s.i.; temperatures to 2000° F., in standard and special types. Catalog on request.

W. S. ROCKWELL COMPANY

ROCKWELL SINCE 1888 BUILT

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2644 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities

For more information circle **109** on inquiry card.

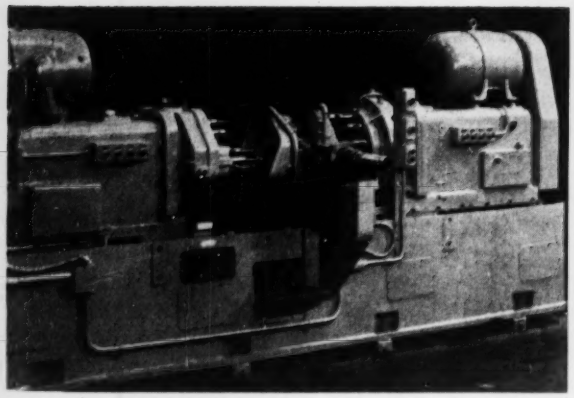


Fig. 1. Multiple-spindle drilling machine.

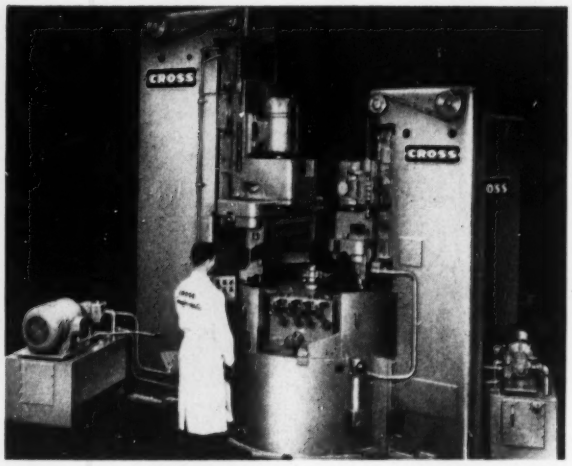


Fig. 2. Multiple-station machine tool of dial type. Work pieces are attached to index table which is rotated from station to station; multiple operations are performed at each station.

Trends in

Machine-tool Automation

Development of machine-tool automation is traced from single-station machines, through multiple-station machines, to the modern transfer machine. The present chief problem—down time because of tool changing—is being attacked by tool programming with the "Toolometer."

by RALPH E. CROSS
The Cross Company

Automation, as coined originally by the automotive industry a few years ago, was defined to mean, "the automatic handling of parts between progressive production processes." With such a definition*, the application of machine-tool automation started with the elimination of work handling.

Single-station Machines

From this beginning, we find the development of many kinds of single-station machines using multiple and combination tooling. These are the machines that simultaneously perform more than one operation on a single work piece. Examples are multiple-slide lathes, multiple-spindle drill presses, two-way, three-way and four-way drilling and boring machines, multiple-spindle milling machines, etc. Figure 1 is typical: It is a two-way multiple-spindle drilling machine which performs 32 operations on a rear-axle housing.

However, single-station machines are, in many instances, over-extended. To use a figure of speech, "they have been stretched until they won't give another inch." Some of these machines have heads coming from all directions, and in such numbers that it is almost impossible to get the work pieces in and out of the fixtures. Changing tools is a major operation.

*Since its original definition, common usage has extended the term "automation" to include complete elimination of manual effort at all stages in production, usually by complete automatic control.

Multiple-station Machines

Such conditions led to the development of the multiple-station machine. First machines of this kind were the dial-type (Fig. 2) and the trunnion-type (Fig. 3) machine. In these machines the work pieces are placed in fixtures which are attached to index tables or trunnions. The parts are indexed from station to station. Multiple operations are performed in each station. It is common practice in multiple-station machines to set aside one station for loading and unloading the work pieces so that this time-consuming operation can be performed simultaneously with the cutting in the other stations.

Dial- and trunnion-type machines bring more operations together than single-station machines, but they have a practical limit—the diameter of the table or trunnion. The larger the table, the greater the indexing error. As the size of the table is limited, the number of stations is limited.

Transfer Machines

The demand for machines with more stations led to the development of multiple-station machines wherein stations are stretched out in a straight line. These are called *transfer machines;* they fall into two general types—the pallet type and the plain type.

In *pallet-type transfer machines* the parts are clamped

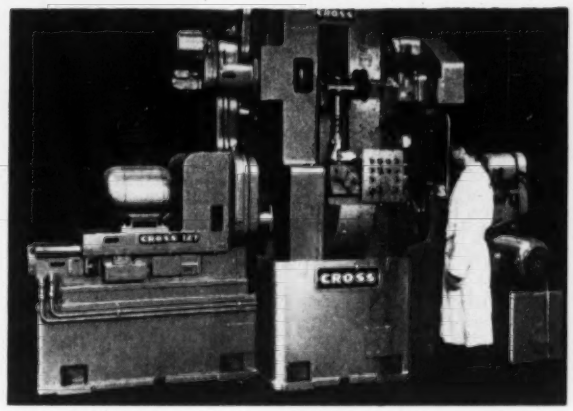


Fig. 3. Trunnion-type multiple-station machine tool in which the work pieces are attached to a movable trunnion. Parts are moved from station to station, with multiple operations performed at each station.

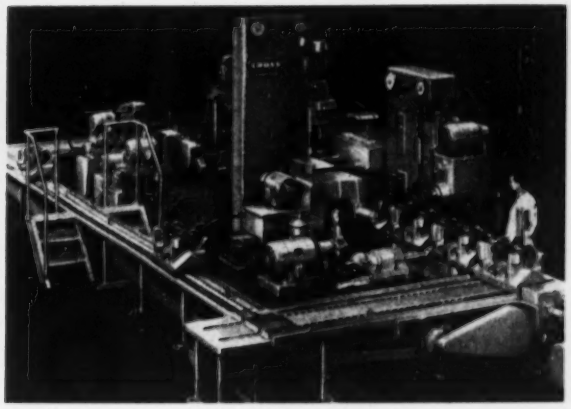


Fig. 4. Pallet-type transfer machine for exhaust manifolds, in which parts are clamped in fixture which is transferred from station to station. Fixture is returned via conveyor.

in fixtures and the fixtures are transferred from station to station. After the operations are completed, the pallet fixtures are returned by a conveyor to the loading station where the parts are unloaded and replaced with unfinished parts, as shown in Fig. 4. Pallet machines are used where it is necessary to change frequently from one part to another; also in single-purpose applications where the part is of irregular shape.

In *plain-type transfer machines* the parts are placed in the loading station; from there they are transferred from station to station (Fig. 5). At the end of the line they are ejected. Parts are located and clamped separately in each station.

Theoretically, transfer machines offer limitless possibilities for combining operations. Machines with automatic positioning devices and automatic cleaning, inspection, and assembly operations are not uncommon today. One "Transfer-matic" for machining V-8 cylinder blocks is 346 feet long, performs 539 operations, automatically handles the part in 7 different positions, and has a capacity of 100 parts per hour; 104 pieces are in process at one time. The entire line (Fig. 7) is under the control of one operator.

Despite the fact that there is no theoretical limit to the number of operations that can be combined into one "Transfer-matic," there is a definite practical limit—*the down time for changing tools.*

Tool Considerations

Consider a multiple-station machine employing 120 tools that need changing every 4 hours. If the tool change time is 2 minutes per tool, the total time to change all tools is 240 minutes, or 4 hours. In other words, the machine will produce for 4 hours and then be down 4 hours for tool changing. If the number of tools is increased to 240, the down time doubles; if the number is increased to 360, the down time triples, etc.; down time increases in some proportion to the number of tools in the machine. This condition is, of course, intolerable, and yet is common. This does not mean that we have reached the limit of machine-tool automation. The problem will not be solved by a new type of machine, but by automatic tool programming and the development of new devices for automatic work-handling. Tool programming may be defined as the scheduling of tool operation from the time the tool is put to work in the machine until it is removed for resharpening. Most tool programming today is under operator control—that is, the operator places the tool in the machine, keeps a mental account of its progress, and removes it when he thinks it is dull. In larger machines, tool programming is non-existent; tools are put to work and forgotten about until they are broken from overuse.

The need for automatic tool programming is apparent when we consider that tools which were once under close observation in single-station machines are now far removed from any immediate personal attention in transfer machines. Owing to the inconsistency of tool performance and other variables, the first requirement of any programming device is flexibility. Over-all master programming of all tools in a machine or process is impractical; too many interruptions occur to disrupt the master program, and it takes too long to develop an alternate program once there is an interruption. *The solution is automatic tool programming for each individual tool.*

"Toolometer"

The "Toolometer" in Fig. 6 is such an individual tool-programming unit. It is a mechanical memory device that counts the number of operations a tool performs while it is working in the machine. After the tool completes its schedule of operations, the "Toolometer" shuts down the machine for a change. The "Toolometer" is flexible and may be changed instantaneously to a new program for any emergency.

Individual tool programming does not reduce down time, but it keeps tool-changing down-time within specified limits. In the operation of a complete line, for example, the down time is controlled and will not exceed a given number of minutes per shift. Further, lines can be designed and programmed to operate with as little as 5 percent down time, regardless of the number of tools in use.

Here's how it is done. A detailed analysis is made of the time required per shift to change each tool. The operations are then grouped and the line is divided into sections, depending on the position of the part and the total time required per shift to change the tools in each section. One section, of course, will account for the greatest amount of down time; this section will determine the down time for the entire line.

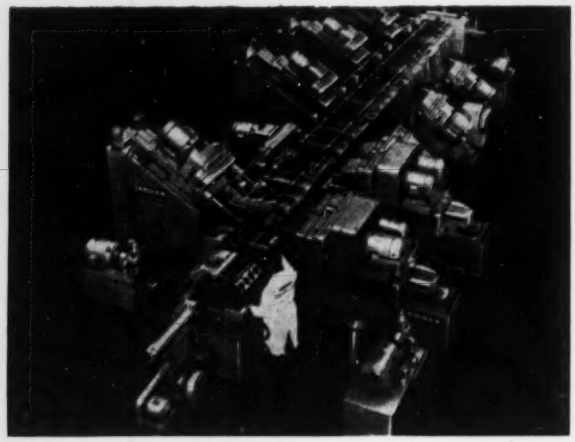


Fig. 5. Plain-type transfer machine in which the part itself is transferred from station to station, being clamped separately in each station.

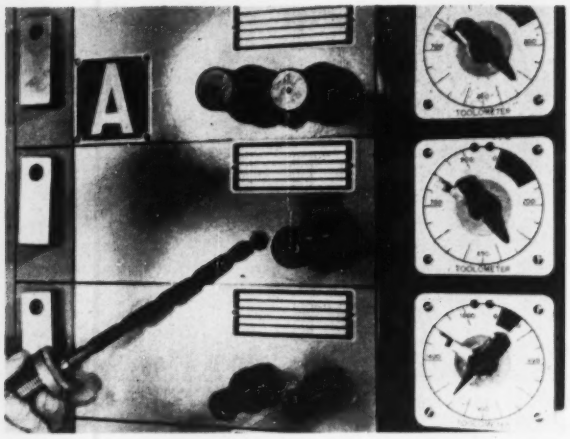


Fig. 6. "Toolometer" for individual tool programming.

In operation, the operator inserts the parts in Station 1 of Section 1 and initiates each cycle. From there on, the parts are handled automatically. The "Toolometers" keep account of the individual tool operations. When it is time to change tools in Section 2, the "Toolometers" shut down this section, but all other sections keep operating. The parts coming out of Section 1 are banked up in front of Section 2, and parts that have been previously banked ahead of Section 3 are fed into the line at this point. After the tools have been changed and the "Toolometers" reset, Section 2 is returned to automatic operation in sequence with the rest of the line. By shutting down only one section of the line at a time, down time for tool changing does not accumulate.

The foregoing is one example of how automatic programming promotes automation, and it immediately points up the need for a new kind of work-handling device—an automatic work banking unit between each section to eliminate the manual handling of parts while the tools are being changed. Also, a similar device at the beginning of the line will displace the operator. Thus this line could be made to operate without any direct labor whatsoever. Manpower requirements would be reduced to one stock handler and two tool-setup men.

With only a little imagination it is easy to visualize how programming and work-handling devices are opening up new fields for combining operations.

Continued progress in automation will no doubt lead into sub-assembly and assembly operation. This will create a demand for additional automatic programming to bring the component parts into the line in the proper amounts, and for additional work-handling devices to place them and assemble them in proper position.

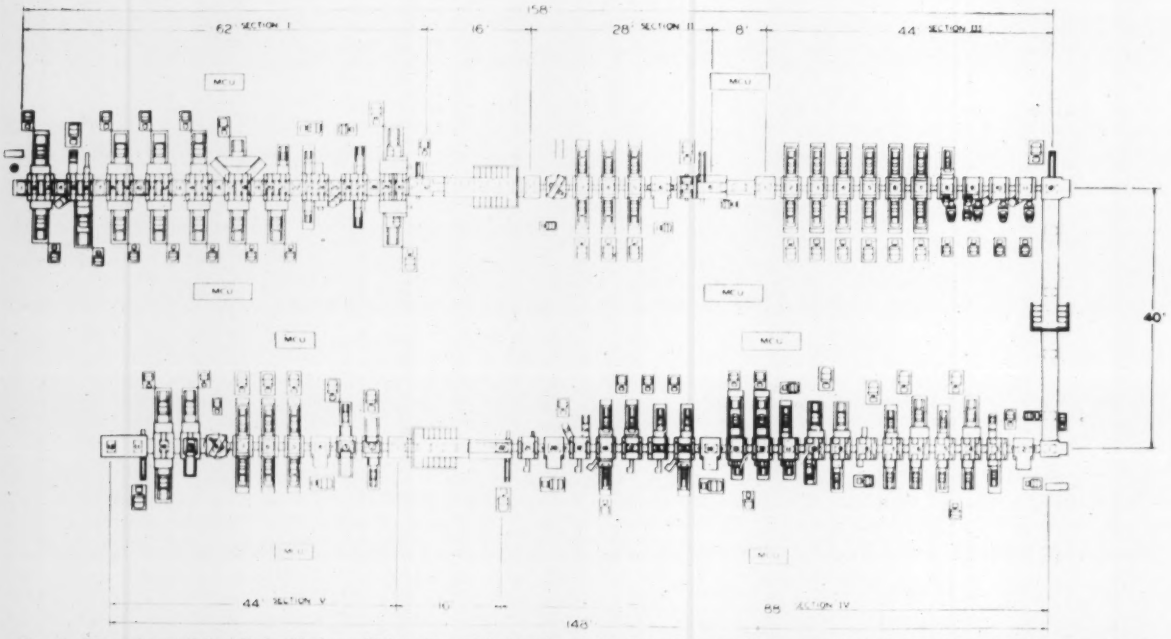


Fig. 7. "Transfer-matic" cylinder-block-machining line with length of 346 feet, 539 operations, and 100-parts-per-hour capacity, all under the control of one operator.

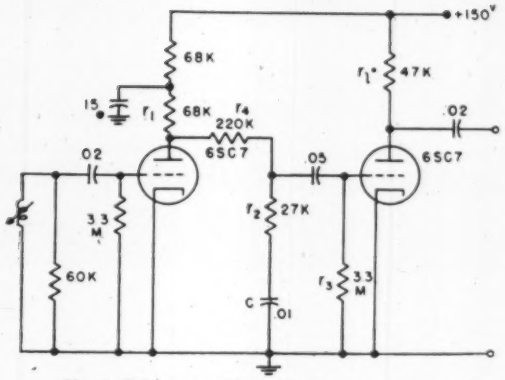


Fig. 1. Tube preamplifier with frequency compensation.

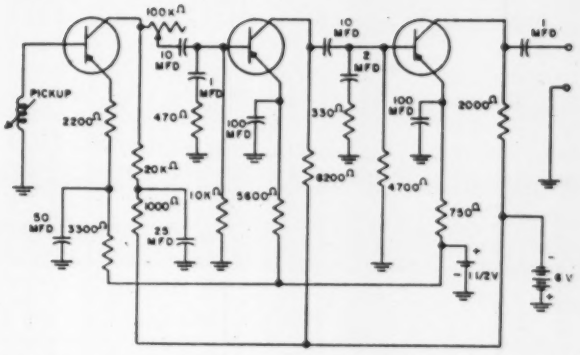


Fig. 2. Equivalent transistor preamplifier.

TRANSISTORS VS. TUBES

Competitive situation of transistors and tubes is clearly illustrated by comparing an audio preamplifier circuit using tubes with an equivalent circuit using transistors.

by R. F. SHEA
General Electric Co.

ONE of the best ways to compare transistors and electron tubes is to illustrate the design of a typical circuit using both tubes and transistors. In this way the differences can be emphasized and the major design details brought out. Therefore, a preamplifier (Fig. 1) such as used to follow a variable-reluctance phonograph pickup, was selected as a typical circuit. The signal levels are about ideal for either type of amplifier, and the necessary inclusion of low-frequency compensation provides an opportunity to illustrate the effect of the different impedance levels encountered with tubes and with transistors.

The 6SC7 tube was chosen for comparison with the type 2N43 p-n-p transistor. The former is used extensively for this purpose and is a representative tube triode. The 2N43 is the high-alpha transistor announced in 1953 by the General Electric Company, and is particularly well suited to this application.

Fig. 3 shows a basic amplifier stage. The tube is unilateral; its input resistance is that of grid resistor r' (at low frequencies), and its output resistance is the r_p of the tube. By contrast, the transistor is bilateral—that is, its input impedance is a function of the load and its output impedance is a function of its source. Further, the parameters of the tube are relatively constant, whereas those of the transistor vary greatly with operating point and with temperature. In addition, both tube and transistor vary to some degree in production.

Typical values of input resistance are in the megohms for the tube, about 50 ohms for the grounded-base transistor, 1,000 ohms for the grounded-emitter transistor. Output resistances are about 50,000 for the tube, 20,000 to 2,000,000 for the transistor, depending on configuration and terminal impedance. Current amplification of the tube is theoretically infinite, as is the power gain. (Actually, both are limited to finite values by the grid resistor.) Current amplification for the transistor is approximately unity for the grounded-base amplifier, about 30 to 100 for the grounded-emitter amplifier. Voltage amplification is about 50 for the tube, may exceed 1,000 to 2,000 for the transistor.

So much for the basic details, now to get down to the problem of designing a preamplifier. The requirements are as follows: input resistance—60,000 ohms; input signal—10 millivolts; output signal—1 volt; frequency response—18-db. attenuation at 800 cycles relative to 50 cycles; noise—50 db. at 50 cycles.

Fig. 1 shows the circuit of a suitable tube preamplifier which has been used for this purpose. The first stage incorporates a filter section in the form of a 68,000-ohm resistor and 15-microfarad capacitor. The effective load resistor of the first stage is 68,000 ohms, which is shunted by the effective impedance of the coupling network. The second grid connects to this network in such manner that

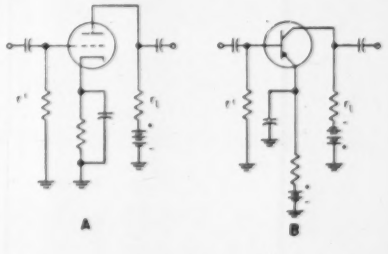


Fig. 3. Basic amplifier stage. A, using tube; B, using transistor.

Abstracted from the article "Transistor Application Fundamentals," by R. F. Shea, *Electrical Engineering*, April, 1954, pages 360-365.

the portion of the first plate voltage appearing on the second grid is attenuated as frequency increases, thus providing the desired frequency compensation. This second grid voltage is amplified and the amplified signal is taken from the second plate.

Fig. 2 shows the equivalent transistor circuit with compensating network. Note the greater number of components required. Separate batteries are used for emitter and collector supplies, plus series resistors for each emitter. The resistors in the base and collector circuits have values much lower than those ordinarily employed with tube amplifiers. These values are dictated by the requirement that temperature stability be good, which necessitates low values. Next, the values of all capacitors are much higher than those used in the tube amplifier owing to the lower values of impedance of the transistor amplifier stages. Similarly, the compensating networks use large capacitance and small resistances, for example 1 uf and 470 ohms, as compared to 0.01 uf and 27,000 ohms. This, too, is due to the fact that the transistor-stage input impedance is about 1,000 ohms, compared to 3 megohms for the tube amplifier. Further, the low value of shunt input impedance makes it impossible to get the same curve of frequency compensation, hence the requirement for the two compensating networks.

Another feature of the transistor amplifier is the use of an unbypassed resistor in the first emitter circuit. This increases the input impedance of this stage to the required 60,000 ohms, although at the cost of some gain. A gain control between the first and second stage adjusts the over-all gain to the desired level.

This amplifier has an undistorted output of 2 milliwatts and an over-all gain of approximately 60 db. Signal-to-noise factor was 50 db. at 50 cycles.

A final comparison is in order. The tube amplifier employs one dual triode versus three transistors, 8 resistors versus 13, 5 capacitors versus 9. On the favorable side for the transistor circuit are (1) the power requirement, 15 milliwatts total versus approximately 2,000 milliwatts, and (2) low voltage requirement, 7½ volts versus 150 (plus filament supply), both of which features make the transistor unit suitable for portable battery-operated equipment.

It is hoped that the preceding treatment will convince the would-be transistor user that, in spite of the greater complexity of the circuits required by these devices, they will "do nearly everything the tubes will do, and even more." The field of transistor application is extremely wide and there is a real challenge to the enterprising engineer who will take the time to become familiar with them.

Atomic Power—When?

Remarks by HENRY D. SMYTH, United States Atomic Energy Commission, delivered at Third Annual Conference of Business Economists, University of Chicago, April 23, 1954.

THERE is no doubt about our technical ability to make electric power from the fission of uranium. We are already doing so in three nuclear reactors, each differing radically from the other in design. The question is: "Can power from uranium be made cheaply enough to be competitive with that from other more conventional fuels?"

The 1952 report of the President's Materials Policy Commission estimated that energy requirements in the United States for all purposes would double in the next twenty-five years, while the consumption of electric energy would triple in that period. Conventional fuels, which are the present sources of energy, are considered adequate to meet these expanding needs up to 1975 with little or no increase in real costs.

Beyond 1975, the picture is more uncertain. Coal in the United States is abundant, but its real cost will probably go up. Proved reserves of oil and gas are respectively 12 and 27 times present annual consumption. Discovery of new fields cannot be guaranteed and already the cost of finding new reserves is rising. With the demand for fuels expected to rise so sharply between now and 1975, there would be good reason to explore other possible sources of energy even if they did not look capable of competing with fossil fuels in the next twenty years.

The energy potentially available in the world's reserves of mineable uranium has been estimated as between 20 and 25 times the energy from world reserves of oil, gas and coal added together.

Nuclear power plants differ from normal power plants only by substitution of a nuclear reactor for the firebox and boiler. The steam turbines will be essentially the same and so will the electric generators. The gradual introduction of nuclear power does not represent a new industry but merely the modification of a familiar one. The change consists in the substitution of a new fuel for an old one, but this must take place rather more slowly than the substitution of oil for coal in commercial power furnaces because a totally different type of furnace is required.

Assuming that the costs of conventional fuels will not go up appreciably before 1975, nuclear fuel will therefore be supplying only 2 to 10 percent of our power needs by 1975. Should power from conventional fuels start to rise materially in cost, nuclear power plants may well come in faster. In fact, perhaps the most important role for nuclear power may be as a restraining force exerted against rising power costs.

We have good reason to hope that by 1960 or 1965, technical advances will be sufficient to justify private capital in picking up most of the financial and technical burden of development and construction.

As a final topic, I should like to return to the question of nuclear power in other countries. In Japan, the estimated cost of power is 20 mills per kilowatt hour, probably the highest of any industrialized country. The best figures I can get as examples of power costs in Europe are: For the United Kingdom, about 7 mills or more per kilowatt hour; for Belgium, 9 to 10 mills; and probably about the same for France. Since the last few mills will be the hardest to cut from our nuclear power cost, it is evident that nuclear power may well be competitive with these foreign costs considerably before they can compete with our own cost of 4 to 7 mills per kilowatt hour. The picture in other countries over the next twenty years may be entirely different from the one I have drawn for this country. Nuclear power may be much more important elsewhere.

Periodicals on Instrumentation

IN RECENT years there has been considerable increase in the world's instrument literature, both periodicals and books. The readers of *Instruments and Automation* will be interested in the periodicals concerned EXCLUSIVELY with instruments and apparatus for measurement, analysis, inspection, testing, computing and automatic control; these are listed in the table.

The periodicals present the new products of the field, their applications, new principles and discoveries, new techniques, and technical articles. Articles in periodicals are unusually helpful sources of information because they (1) present the principles and techniques in brief form, (2) are likely to be somewhat more specialized than books because each article deals with a single subject, and (3) are more recent; the time required for writing and publishing books makes it impossible for them to contain the latest information.

No information has been received in the office of the Instruments Publishing Company as to publications on instruments appearing behind the iron curtain.

Publication	First Issue	Publisher	Address	Number of Issues per year	Annual Subscription Price (U.S.A.)
Archiv fuer Technisches Messen	1932	R. Oldenbourg Verlag	Lotzbeckstrasse 2 b, Munich, Germany	12	36.60 D.M.
Australian Journal of Instrument Technology	1944	Australian Society of Instrument Technology	c/o F. O. Barrett & Co., 422 Collins St., Melbourne Australia	4	£2—2 s
Calculo Automatico Y Cibernetica	1952		Serrano 123, Madrid, Spain	4	60 pesetas
Computers and Automation	1952	Edmund C. Berkeley & Associates	36 West 11th St., New York 11, N. Y.	10	$4.50
Feinwerktechnik	1893	C. F. Winter'sche Verlagshandlung	Fuessen, Baeyern, Germany	12	40 D.M.
Instrument & Apparatus News	1953	Instruments Publishing Co.	845 Ridge Ave., Pittsburgh 12, Pa.	6	$10.00
Instrument Manufacturing	1933	Instruments Publishing Co.	845 Ridge Ave., Pittsburgh 12, Pa.	6	$2.00
Instrument Practice	1946	United Trade Press, Ltd.	9 Gough Square, Fleet St., London E. C. 4, England	12	30 shillings
Instruments & Automation	1928	Instruments Publishing Co.	845 Ridge Ave., Pittsburgh 12, Pa.	12	$4.00
ISA Journal	1954	Instrument Society of America	1319 Allegheny Ave., Pittsburgh 33, Pa.	12	$5.00
Journal of Scientific Instruments	1823	Institute of Physics	47 Belgrave Square, London S. W. 1, England	12	£4
Kaisoku (Instruments)	1951	Japanese Instrument Society	c/o Dr. T. Isobe, Dept. of Technical Measurements, University of Tokyo, Tokyo, Japan	12	$4.00
Mesures et Controle Industriel	1936		79 Avenue des Champs Elysees, Paris 8, France	12	3800 francs
Microtecnic (Three editions: German, French and English)	1947	Scriptar, Ltd.	23 Avenue de la Gare, Lausanne, Switzerland	6	$12.00
Misure e Regolaziore	1953	Associazione Termotecnica Italiana	Viale Piare 20, Milano, Italy	6	4000 lire
Regelungstechnik	1953	R. Oldenbourg Verlag	Lotzbeckstrasse 2 b, Munich, Germany	12	45.60 D.M
Review of Scientific Instruments	1922	American Institute of Physics	57 East 55 St., New York, N. Y.	12	$8.00
Scale Journal	1914	Scale Journal Publishing Co.	176 West Adams St., Chicago 3, Ill	12	$3.00
Transactions of the Society of Instrument Technology	1949	Society of Instrument Technology, Ltd.	80 Bishopsgate, London E. C. 3, England	4	50 shillings

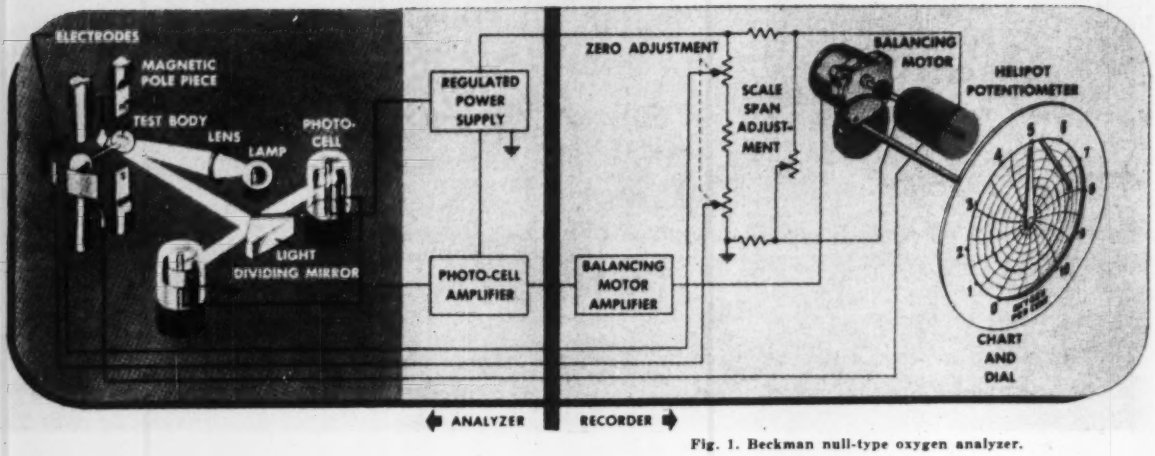


Fig. 1. Beckman null-type oxygen analyzer.

Measurement of OXYGEN TRANSFER

Oxygen analyses of effluent gas from biochemical processes supplied with oxygen gives data on the oxygen uptake within the system. Use of a magnetic oxygen analyzer in studies of aerobic oxidation of dairy wastes is demonstrated. The rate of oxidation by the bacterial flora and the efficiency of O_2 transfer to the organisms are readily determined. The utility of such instrumentation in research and operation of sewage, industrial-waste, and fermentation plants is discussed.

by SAM R. HOOVER, LENORE JASEWICZ, NANDOR PORGES
Eastern Regional Research Laboratory

OXYGEN-UPTAKE measurement from the gas phase appears to have utility in both research studies and control of aerobic treatment processes. The instrument employed was the magnetic oxygen analyzer developed by Linus Pauling and associates[1] for the armed services during World War II, commercial models of which are manufactured by Arnold O. Beckman, Inc.* The "Model C" instrument with an operating range of 100-160 mm. was designed for physiological studies. This range covers oxygen removals of 0-33 percent at ordinary atmospheric pressures with an accuracy of ± 1 percent of scale range or about ± 0.1 percent O_2, and is therefore well suited to the study of aerobic fermentation processes. The principles and applications of oxygen recorders in industry were reviewed recently by Riggs[2], but the application to measurement of oxygen removal in biochemical oxidation processes was not discussed.

Oxygen Analyzer

The basic principle is that oxygen is the only common paramagnetic gas—that is, it is attracted into a magnetic field. A tiny glass dumbbell filled with nitrogen or oxygen is suspended between two pairs of magnetic-pole tips by a stretched quartz torsion fiber (Fig. 1). The oxygen in the gas stream is attracted to the area between the poles, thus displacing the dumbbell. The dumbbell rotates in the magnetic field to an equilibrium position dependent on the magnetic rotational force and the torsional force of the quartz fiber. A mirror attached to the dumbbell indicates the equilibrium position by reflecting a light beam on a calibrated translucent scale. In the recording apparatus, an electrostatic compensation is used to maintain a null-point balance. The balancing electrostatic force is converted into a potential that can be recorded on commercial recording potentiometers[2].

The gas sample is passed continually through the apparatus, which has a capacity of 9 cc., at any flow rate between 50 and 260 cc./min. Water vapor dilutes the oxygen; therefore, samples must be either wet or dry. In the work reported here, the compressed air used was passed through water at the operating temperature of the aerator and sampled intermittently to determine the O_2 content of the air. An alternate procedure was to pass the air through the aerator at extremely high rates to get the control value. The gas sample was removed from the aerator by an inverted funnel with the rim just below the surface of the liquid. The outlet of the oxygen analyzer vented the gas at atmospheric pressure. A noteworthy feature of this system of analysis is that the oxygen transfer in the liquid is given directly by dividing the decrease in O_2 pressure by the observed pressure of the control.

Design of Experiment

A stable, balanced, aerobic flora was established which oxidized at a high rate a synthetic milk waste consisting of 0.1 percent solution of skim milk in water. The aerator was a Humfeld type[3], with an inverted funnel at the liquid level to catch the sample of gas coming off the surface. The compressed air supplied to the system was passed through a dust trap and a calibrated flowmeter. The effluent gas sample was similarly measured and passed through the oxygen analyzer. The other conditions of the experiments were the same as those described previously[4]. Vigorous agitation and mixing of the solution with accurate

Presented at Conference on Instrumentation in Water, Sewage and Industrial Waste Treatment, Manhattan College, Riverdale, New York, on May 14, 1953.

* Mention of products does not imply endorsement or recommendation by the Department of Agriculture over other products of a similar nature not mentioned.

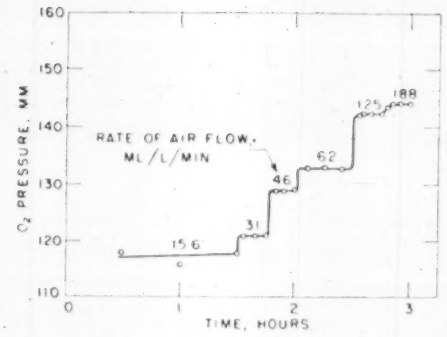
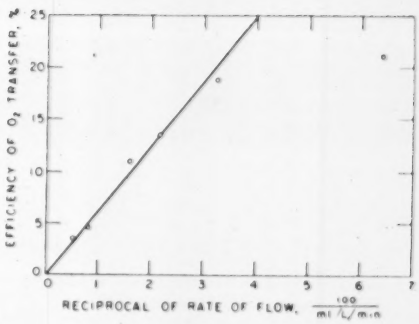


Fig. 2. Oxygen content of effluent air from aerator.

Fig. 3. Oxygen transfer efficiency vs. reciprocal of rate of flow. The linear relationship from 0 to 3 units on the abscissa indicates a constant rate of oxygen utilization; the point at 6.4 units deviates from the linear relationship, thus showing that the oxygen requirement is not satisfied.



control of temperature and aeration, essential features of this study, are readily obtainable in this equipment.

After several exploratory runs, the oxygen removed by the culture was measured as a function of the rate of air flow into the system. The purpose of the experiment was to test the utility of this type of measurement; no attempt was made to obtain optimum rates of biochemical oxidation.

Results

It was difficult to get steady readings of O_2 pressure in the effluent gas at extremely low air flow. After some adjustments of the rate, however, the system stabilized at about 118-mm. O_2 pressure at 15.6 ml./L. air flow (250 ml./16 L.). The data of Fig. 2 were then obtained within a 2-hour period. The response of the instrument to a change in air supply was rapid; a new equilibrium position was reached in 2 to 3 minutes, the time required to flush the system. The data are given in tabular form to show the simplicity with which the O_2 transfer and the rate of O_2 utilization can be calculated.

Oxygen Consumption by 16 L. of Aerator Culture as a Function of Air Supply

Air Flow	*Oxygen Utilization*			
ml./L./min.	*mm.*	*percent*	*ppm./min.*	*ml./gm./hr.*
15.6	31.5	21.1	0.92	15.6
31.3	28.0	18.7	1.65	27.7
46.9	20.5	13.7	1.81	30.8
62.5	16.5	11.0	1.94	32.6
125	7.0	4.7	1.65	27.9
188	5.25	3.5	1.86	31.5

Percent data in column 3 were calculated by dividing column 2 by the O_2 content of influent air, 149.5 mm.

The ppm./min. data in column 4 were calculated as follows:

$$\text{ppm./min.} = [(\text{air flow})(\text{mm.})/760][32/22.4]$$
$$= (\text{col. 1})(\text{col. 2})(1.88)(10^{-3})$$

The actual atmospheric pressure should be used for most accurate results.

Gas law corrections for temperature (30 deg. C.) were not made.

Data in column 5 were calculated on basis of 2500 ppm. solids present. This value is an approximation.

The low rate of oxygen uptake at the lowest air flow is noteworthy. Although 21 percent of the oxygen was taken from the air stream, leaving 79 percent unused, it is apparent that the bacterial cells were receiving insufficient oxygen. The dispersion of air was not adequate to maintain aerobic conditions; the instability of readings already referred to undoubtedly reflects this unbalanced biological situation. Satisfactory steady-state conditions were maintained at the higher rates of aeration, as shown by the fact that the rate of uptake varied only between 1.6 and 1.9 for a 6-fold increase in rate of aeration.

The constant rate of oxidation on a volume or a weight basis, if adequate air is supplied, was predicted from previous studies, wherein the rate of oxidation was constant above about 0.5 ppm. dissolved oxygen[5]. This fact makes possible an algebraic or graphical solution of the data, as illustrated in Fig. 3.

Inasmuch as the O_2 consumption is independent of rate of aeration, the transfer efficiency (x) times the amount of O_2 supplied (y) is a constant (k)—that is, $xy = k$. This is the equation of a simple hyperbola. Plotting y, oxygen transfer, against 1/x, the reciprocal of the rate of aeration, produces a straight line with a slope k, which is proportional to the rate of O_2 uptake. The abscissa of Fig. 3 is in terms of air flow; for calculation of O_2 uptake it must be converted to oxygen flow. The abscissa is therefore divided by 149.5/760, or 0.197, to obtain the slope of the line in terms of oxygen uptake. A resultant value of 1.23 ml. O_2/L./min. is obtained, which multiplied by 32/22.4 equals 1.76 ppm. O_2. This value can be compared with the mean of the last 5 values in column 4 of the table, which is 1.79. Thus the graphical and arithmetical solutions agree. The marked deviation of the point of the lowest aeration rate is again evidence of a failure to supply adequate oxygen to the microorganisms.

Fig. 3 has additional value for research purposes in that the "breakpoint" at which the air supply becomes insufficient is clearly shown. The direct plot of oxygen transfer vs. rate of air flow (not shown) is more difficult to interpret because the hyperbolic function is changing rapidly in the critical region, and the point where the air supply becomes insufficient is not apparent.

In biochemical research, the rate of oxidation per unit of cell tissue present is an extremely valuable parameter. This rate, called the oxidation quotient, QO_2, is readily calculated from the data obtained if a determination of cell dry weight is made.

Discussion

The experiment performed illustrates the valuable data obtainable on an aerobic oxidative system by use of O_2 analysis. The activity of the activated-sludge floc and the performance of the air-dispersing system both can be determined almost instantly. Such information is essential in research studies. In control of plant operation, this type of analysis could be used easily to record plant performance, a record that would show directly whenever the system went out of balance. The instrumentation required to convert this measurement to a recording-controlling system would not be difficult; the air supplied to the activated-sludge plant could be controlled to maintain an O_2 content of the effluent gas within a definite range. At times of low oxygen demand much less air would be pumped into the system.

The utility of such measurements is not restricted to sanitary engineering; they could be applied in fermentation plants using aerobic processes for the production of antibiotics, vitamins, and food and feed yeasts; they can be applied directly in this whole field of aerobic biochemical processes.

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CONTROL VALVES

A resume of valve operators and bodies—including basic features, valve-selection, and valve sizing.

by RICHARD E. LOVE
Minneapolis-Honeywell Regulator Co.

AUTOMATIC CONTROL VALVE is the final element in the control loop (Fig. 1). To obtain good control, all elements in the loop must function as a team. The control valve consists of a valve and an operator. The operator receives a controlled signal and moves the inner works of the valve.

No one valve is suitable for all control applications. Industrial applications require all of the so-called standard operators and bodies, plus special high- or low-temperature and pressure types. Sewage and water-treatment applications require many operators and bodies owing to the requirements of large flows and low pressure drops, and extremely corrosive fluids.

Fig. 2 presents most of the common operators and bodies. The operators are (left to right): a spring-opposed diaphragm type, a springless-diaphragm type, a cylinder actuator, a small electric motor, a large electric motor. The body styles depicted (left to right) are: the so-called diaphragm control valve or globe type, the butterfly valve, the Saunders Patent type, the pinch valve, the Venturi-throat (or angle) body, and the three-way valve. Except for force and physical limitations, any of the operators may be mounted on any of the valves.

Operators

Fig. 3 shows a *spring-type diaphragm operator;* a controlled loading pressure is opposed by a calibrated spring. The standard control range of the instrument industry is 3-15 psi. Springs are made accordingly, but various other springs are available for overcoming conditions and control features as required.

To overcome the loss of power which occurs in the compressing of the spring in a spring-type operator, a *springless operator* can be used. Relays are required for throttling service. This operator can employ full power in either direction and at any position of the stroke. Fig. 4 shows a basic outline of this type of operator.

As Fig. 5 shows, a *cylinder actuator* is essentially the same as the springless diaphragm operator. However, it can be made to have a much longer travel, which is a restriction on the diaphragm operator. In water and sanitation plants these operators are used to handle the large-travel requirements of a gate valve.

Presented at Conference on Instrumentation In Water Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.

The *electric motor* has not yet been used to great extent for control-valve operation in water and waste plants; air and hydraulic motors are an inexpensive source of power compared to the electric motor of the same power rating. Fig. 6 shows a large and a small motor; there is no intermediate size. Small motors are used in heating, ventilating, and light industrial processes. Large motors are used on large pipeline and central-station control valves. Intermediate-size motors will undoubtedly be developed, however, due to increasing interest in electrical control actions.

Bodies

Fig. 7 shows the inner valve, or plug, of a valve body of double-seated construction. (Single-seated construction for tight shut-off or for small flows is basically the same except that the valve has only one seat and one disk.) It is made in sizes from ½ inch to 20 inches; sizes above 12 inches are specially engineered products. This construction can be made in most alloys. Where a reasonable pressure drop can be expended, a diaphragm control valve insures the best control due to the characterized shape of its valve plug and to the relatively slow uncovering of the valve orifice. Very small inner valves are available for chemical feed applications.

Where low pressure drops through a valve are necessary, or where large valves are needed, the *butterfly valve* (Fig. 8) is used. The valve has a circular flat disk which affords little resistance to flow. Filter plants, precipitators, and sewage plants are large markets for the butterfly valve. A butterfly valve can be rubber lined for either corrosion resistance or tight shut-off characteristics. The control characteristic of a butterfly valve is not as good as the diaphragm control valve. Attempting to control below 20 percent of full flow with a butterfly valve becomes difficult. However, as many water-treating plants shut down when the flow falls below 20 percent, a butterfly valve finds extensive use.

The erratic torque requirement curve over the rotation of a butterfly valve prevents valves on throttling service from opening much above 60 degrees of rotation. Fig. 8 is an outline of a butterfly valve of the full-bodied type. Wafer-type valves are valves where the body is just a hollow flange with the disk in the center. When the valve disk opens it actually turns into the pipeline.

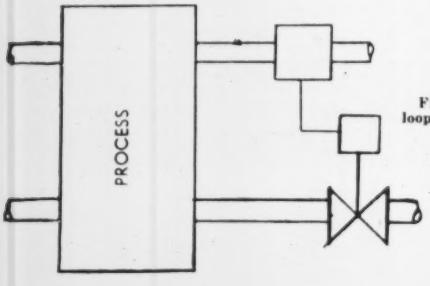

Fig. 1. The control loop.

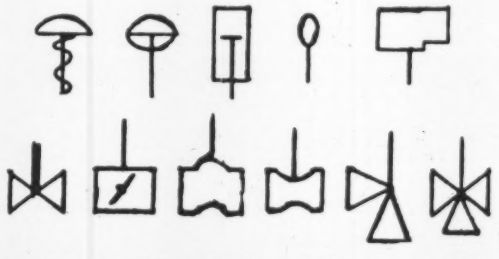

Fig. 2. Common operators (top), and valve bodies (bottom).

Fig. 3. Spring-type diaphragm operator.

Fig. 4. Springless valve operator.

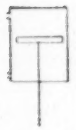

Fig. 5. Cylinder actuator.

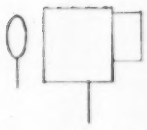

Fig. 6. Electric-motor operators.

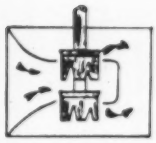

Fig. 7. Double-seated valve plug.

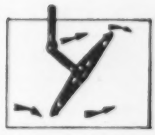

Fig. 8. Butterfly valve.

Fig. 9. Saunders Patent valve.

The *Saunders Patent* valve (Fig. 9) was a special-application valve which has become standard in recent years, and has found great use in sewage, water treating, and industrial waste plants. The Saunders valve has a flexible diaphragm acting as both the valve disk and packless stem seal. The whole inner portion of this valve can be lined with materials such as rubber, glass, lead, saran, and others. The diaphragms are available in almost any commercial flexible plastic. This valve is excellent for handling suspended solids.

Owing to the large diaphragm area, great power is necessary to operate Saunders Patent valves; relatively large operators must be used on even the smallest valves. Sewage sludge, acid water, and alkalies find nothing to attack in a valve lined with the proper material. Temperature is a limitation as flexible plastics have a high-temperature limitation of about 240 deg. F., and at temperatures below 0 deg. F. flexible plastics become brittle. This valve has a low inherent pressure drop, but relatively poor control characteristics.

The *pinch valve* (Fig. 10) is simply a flexible tube of plastic or rubber on which a scissor-type linkage tightens to close the valve. This valve has no pressure drop in the wide-open position except that of its length in pipe size. It has the temperature limitation of a Saunders Patent valve and low pressure-limits owing to the use of the flexible tube section. This valve should not be used on fine control services because its control curve is rather erratic.

The *angle*, or *Venturi throat*, valve is an adaptation of the diaphragm globe-type valve. Its shape (Fig. 11) requires the flow to change direction once. Many adaptations are available. This valve is most common on high pressure drops. It is used also for slurries and fluids carrying abrasive materials which can't be handled in a rubber-lined or soft-plastic-lined valve.

The last valve body style described is the *three-way valve body*. This valve can either be mixing, as shown in Fig. 12, or diverting. In diverting service the arrows are reversed. Backwash of filters is a common use for this valve. It is used also in pairs, in small sizes, as the hydraulic pilot valve for automatic cylinder operators. pH control has long used this valve to dump fluid when a limit has been exceeded.

Control-Valve Selection

Selection of a control valve depends on many things—pressure, temperature, pressure drop, fluid characteristics, corrosiveness, tight shutoff, type of control, and rangeability. The last two—type of control and rangeability—govern valve characteristics and are closely related. The valve should match the instrument; if the instrument is a wide-proportional-band controller you want a valve that compares with it. This means a valve operator that is sensitive to small signals from the controller, and also a valve disk that gives accurate control over the entire valve travel. *Rangeability* is the ratio of the maximum controllable flow to the minimum controllable flow, and is a function of the valve plug or disk.

Fig. 13 presents curves of percent of stem travel vs. percent of total flow. The top curve is an equal-percentage curve; the second is a curve of a linear-valve plug. The straight line through the center is representative of the three-way mixing valve. The curve second from the bottom is of a Saunders Patent valve; the erratic portion in the upper section is due to changes in the over-all body diaphragm shape. The lower line is of a butterfly valve.

As you can see, when a butterfly valve is 10 percent open you have 20 percent of the flow passing through it; when it is 20 percent open you have about 55 percent of the total flow passing through it. A characteristic curve of this type means that there is little sensitivity of control in the flow range below 50 percent. A small change in valve travel produces a large change in flow. This is true also of the Saunders Patent type of valve and of a pinch valve. In water-treating and sewage plants there is usually a low-flow cutoff on the entire plant at about 20 to 25 percent of total flow. This fact greatly helps the control characteristic of the butterfly, Saunders Patent, and pinch valves in these plants. The rangeability of a diaphragm control valve is about 50:1. A butterfly-valve rangeability is about 10:1.

Valve Sizing

Correct sizing of a valve is very important. There are many methods of sizing, such as nomograph charts, slide rules, capacity tables, etc. The basis of most of these is the *flow-coefficient sizing method.*

The flow coefficient (C_v) of a valve equals the gpm. of water that a wide-open valve passes with a pressure drop of 1 psi. across the valve, as shown in Fig. 14. A glance at C_v tables for different types of valves can give you a clear picture of the relative capacities of the different valve bodies.

Each type of valve of every size has a flow coefficient. The factors affecting the choice of a valve size are the quantity flowing, the specific gravity of the fluid, and the pressure drop through the valve:

$$C_v = Q(SG/\triangle p)^{1/2}$$

This equation is for a liquid; for gases and vapors other factors affect the variables in the basic formula. When the formula is solved, the C_v is checked against a manufacturer's tables and a correct valve size can be obtained.

Water-treating, sewage, and industrial-waste plants are interested in quality control, low pressure-drops, large flows, corrosion resistance, and economy; no one type of valve is chosen for all services. Each application has a specific valve best suited to handle it, and each specific valve has a job that it does best.

Fig. 10. Pinch valve.

Fig. 11. Angle valve.

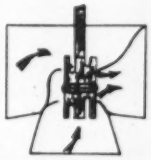

Fig. 12. Three-way valve.

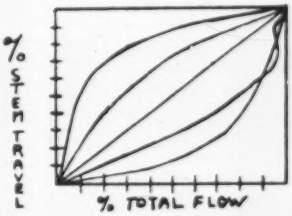

Fig. 13. Characteristic curves of stem travel versus flow. Top curve is equal-percentage curve; second is a linear-valve plug; straight line represents 3-way valve; second from bottom is Saunders Patent valve; lowest is for a butterfly valve.

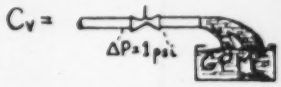

Fig. 14. Setup for measuring Cv.

Control of Chemical Processes

This eleventh installment presents available electropneumatic (combination electric and pneumatic) and mechanical controllers of American, British, and German manufacture. The entire series is being made available in book form.

by
A. J. YOUNG

ELECTROPNEUMATIC, MECHANICAL CONTROLLERS

ELLIOTT BROTHERS (LONDON) LTD.

"Trimode" Controller

This controller can be adapted to receive either electric or pneumatic signals; in the form shown in Fig. 11-1 it is used with an electric input. The output in either instance is an air pressure of the standard range.

Referring to Fig. 11-1, it will be seen that the proportional band is adjusted electrically and the electrical output from the proportional unit is fed to an electropneumatic converter. The output from this converter is added to integral and derivative action units as shown in Fig. 11-2. Both actions are generated in a silicone-filled system and applied to a balance arm as shown. The restrictors are of needle valve type. This controller has been designed with the basic theory well in mind and contains refinements shown only partly in the three figures.

The theoretical equation expressing the behavior of the controller shows that the interaction factor is $1+(5/4)\,(r/s)$. This is only of interest to the user, however, as a means of finding the ratio r/s which gives maximum phase advance—for those applications in which it is required. The ratio, which is not critical, is found to be $r/s = 0.8$. The interaction factor is then 2, and the phase advance available is about 45° for $S =$ operating period.

It is important to note that the user in this instance is not concerned with the nominal times (r and s) but with the effective times (R and S) which will be set on the dials. For $r/s = 0.8$, $R/S = 0.2$; this is the value of R/S recommended by the makers.

This controller is especially interesting in that provision has been made for setting the *effective* proportional band width, and the integral and derivation action times, directly on the setting dials.

The setting dials appear as in Fig. 11-3. They consist of a proportional band dial, two dials and a knob. The inner carries a pointer, which is set against the desired integral action time, on the scale engraved on the outer dial. Derivative action time is set by means of the knob by setting its pointer against the required value of the ratio R/S on the scale. Dials can be locked in this position, so that R/S remains constant irrespective of the values of R and S.

The pointer carried on the left-hand side of the outer dial must be set at the value of R/S required on the short scale. This ensures automatic adjustment of proportional band width, so that its *effective* value remains constant.

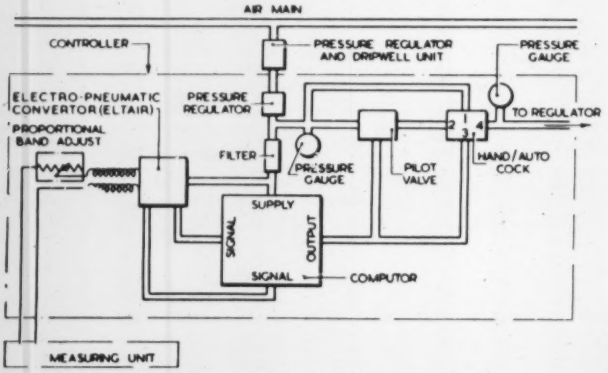

Fig. 11-1. Components of the "Trimode" controller.

SIEMENS & HALSKE (German)

"Electro-Pneumetische Regler"

This controller (Fig. 11-4) generates its actions pneumatically in a manner similar to other controllers with integral (h) and derivative (i) units arranged in "series." The interaction factor is thus $1+(2r/s)$, and the most powerful derivative action will be available with $s = 2r$. At this setting the interaction factor will be 2.

Interesting features of the controller are that it uses an operating air pressure much lower than normal and that it has an electric system for providing motion of the flapper (F) proportional to deviation. The controller is

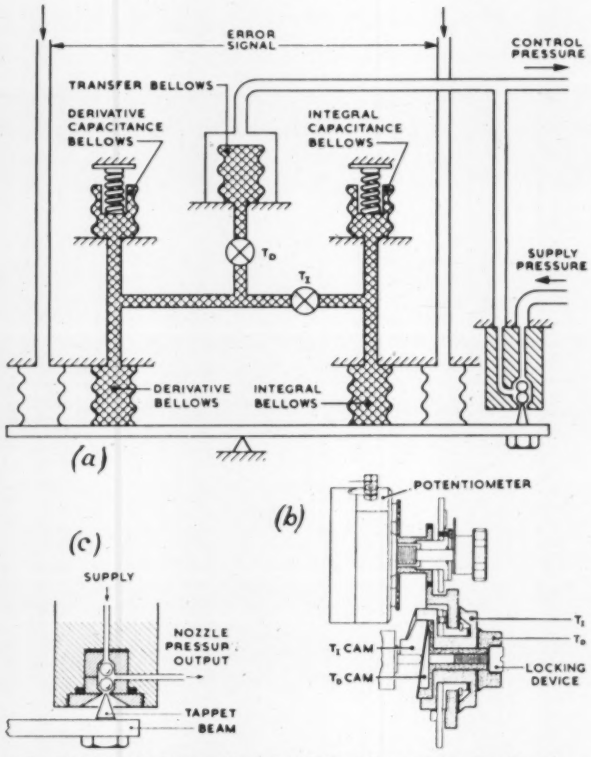

Fig. 11-2. Force-balance unit of the "Trimode" controller. Top illustration shows force-balance unit that controls relay at right-hand end of beam. Relay is shown at lower left. Lower right shows inter-relation between dials so that constant proportional band width is maintained irrespective of independent adjustment of R and S, the derivative and integral action times.

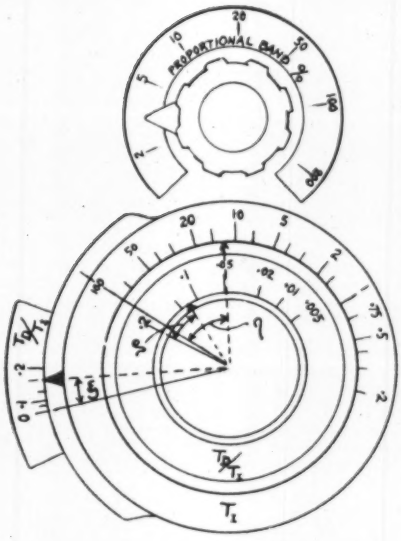

Fig. 11-3. Dial arrangement of "Trimode" controller, consisting of a proportional band dial, a dial with pointer for integral action time, and a derivative action knob which is set against required value of R/S on the scale carried by the integral action dial. A lock on the dials insures that the effective value of the proportional band width remains constant, independent of the values of integral and derivative action times.

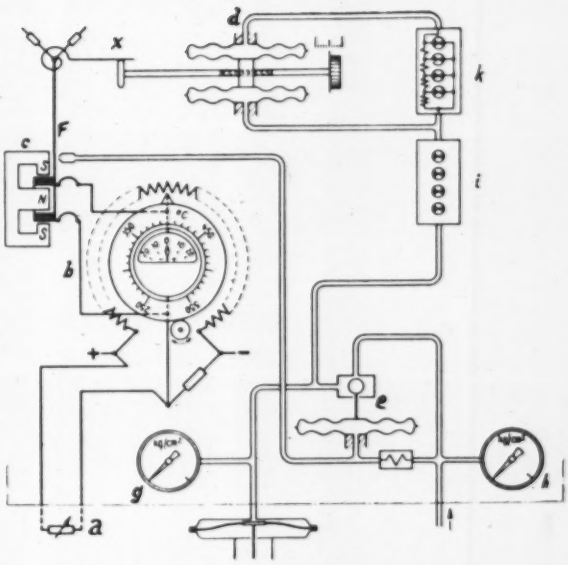

Fig. 11-4. Siemens & Halske "Electro-Pneumatische" controller, which uses pneumatic technique for control actions, but positions the flapper electrically.

designed for a resistance thermometer (a), as the detecting element and the unbalance from the resistance bridge (b) is fed to the coil shown in the field of a permanent magnet (SNS). Any out-of-balance current produced by a deviation from desired temperature will thus cause a proportional movement of the flapper. Desired value is set on the bridge and proportional band width by adjusting the point X (on the lever controlling the restoring spring of flapper F by the movement of the feedback bellows d.

The temperature at which control is holding the process is read by adding the reading (+ or −) of the center pointer (which gives deviation from desired value) to the desired value set on the circular scale as shown. The low air pressure used necessitates the unusually large diameter of the capsule which operates the relay valve from nozzle pressure.

MECHANICAL CONTROLLERS

It is in the field of ratio control—of great importance chemically—that there are to be found control systems whose purely mechanical components are undoubtedly the principal components and whose pneumatic or electrical components play subordinate roles. The reason is that the determination of ratios by levers, gears, cams, etc., is of unquestionable accuracy. There is no "error" or "drift" in a gear-train; and the backlash, if present, is ordinarily negligible.

PROPORTIONEERS, INC.

"Synchro-Master"

This automatic control system utilizes the differential principle of control. Perhaps the simplest example of this principle is an equal-arm horizontal Class I lever (fulcrum in center) which automatically balances two vertically-directed forces A and B, force A being unpredictably variable, force B being exerted by a solenoid, and the automatic control feature consisting of a carbon rheostat actuated by the lever. Whenever the value of A changes, the lever starts to tilt, causing the rheostat to increase or decrease the solenoid's force in order to rebalance A and B and bring the lever back to horizontal. The ratio in this example is 1:1.

In order to utilize this principle in controlling rotating machines, a geared mechanical differential is substituted for the lever. Fig. 11-5 shows a machine A against which the rotation of machine B is to be synchronized. The rotation of A drives side gear 1 counterclockwise while the rotation of B drives side gear 2 clockwise. If gears 1 and 2 are turning at exactly the same speed, differential pinion 3 will revolve, but its spider-shaft 4 will not move. Any difference in the speeds of gears 1 and 2 will cause spider-shaft 4 to be carried in the direction of the faster-moving side gear. By linking spider-shaft 4 to a means of controlling the power flow to machine B, an increase in the speed of A will increase the power flow to B until B's speed again matches A's. An increase in the speed of B will cause its power to be reduced until its speed again matches the speed of A. Therefore, B's speed must follow A's at any load within B's power range.

The control rate of a differential used in this way is asymptotic in character since, as the speeds of the side gear approach synchronism, the *rate* of control change decreases. This is an inherent anti-hunting characteristic and, since the side gears run continuously, the forces which position the spider-shaft 4 are the same whether it is moving or not.

In chemical process control, most ratios are other than 1:1. Referring again to the simple lever, ratios other than 1:1 can be produced by relocating the fulcrum so that the relative lengths of the two arms are inversely proportional to the required ratio between the two forces. The differential in Fig. 11-5 can be made to do the same thing by changing the drive ratios to the side gears. If the number of teeth on the pinion of machine A is reduced one-half it will have to turn twice as fast to bring its side gear up to the speed of that driven by machine B. Any fixed ratio is possible by proper gearing and if a speed changer or integrator is connected between the machine and its pinion, variable ratios are obtained. Fig. 11-6 is a refinement of this scheme arranged to provide a variable speed output with positive rotation through zero to reverse. The variable speed drive to side gear A can be adjusted to turn A either faster.

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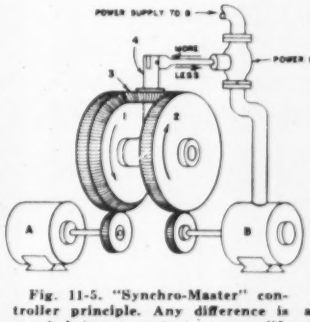

Fig. 11-5. "Synchro-Master" controller principle. Any difference in speed between motors causes differential spider to vary power to follower motor.

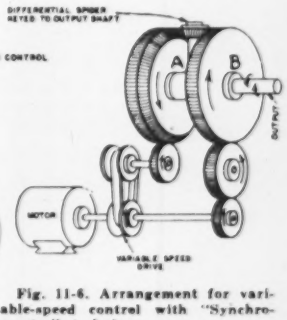

Fig. 11-6. Arrangement for variable-speed control with "Synchro-master" technique.

INSTRUMENT SPRINGS

Few instruments are constructed without springs. Important spring factors are (1) force-deflection characteristic, (2) hysteresis, (3) drift, (4) temperature coefficient, (5) space requirement, and (6) design calculations. Typical calculations and applications are presented.

by M. GERARD FANGEMANN
John Chatillon & Sons

INSTRUMENT ACCURACY often depends on the efficiency and accuracy of one or more springs. Few flow meters, accelerometers, weighing scales, pressure indicators, or instruments of any type are constructed without precision springs.

A precision spring is one that is calibrated, has little or no hysteresis or drift errors, has little deviation from straight-line relationship between load and deflection, and is unaffected by temperature changes. The spring materials that are used in the most important applications are (1) spring steel, (2) phosphor bronze (3) beryllium copper, (4) stainless steel, and (5) "Iso-Elastic"*. Each of these materials has a proper use and must be chosen according to the application requirements.

The table lists the main spring materials with their most important physical properties.

Hooke's Law

Precision instruments require springs that have "straight-line" characteristics—that is, the force exerted by the spring should be directly proportional to the deflection, as illustrated in Fig. 3.

It is possible to have good straight-line characteristics with conventional spring materials—if sufficient space is available for the design. For example, a steel spring requires five times or more the space requirement for a spring made from "Iso-Elastic" in order to obtain equivalent straight-line characteristic. (Springs of "Iso-Elastic" usually have deviations from straight-line characteristic of less than 0.05 percent total deflection.)

Hysteresis

Instrument springs must have minimum hysteresis. Hysteresis, or back-error, is the difference occurring at mid-point between the loading and un-

* Trade name, John Chatillon & Sons; patent 2174171. "Iso-Elastic" is a special alloy developed with the assistance of Professors F. Sayre and A. V. De Forest. It is an alloy containing 36 percent nickel and 8 percent chromium, and derives its spring properties by means of cold reduction in area (reducing diameter through successive dies) usually maintained to 93½ percent. The hysteresis and creep characteristics of "Iso-Elastic" equal that of beryllium copper but the material is temperature compensated (low-temperature coefficient of modulus of elasticity). It has the advantage over Ni-Span-C that it is non-hardenable and therefore does not have to be heat treated for long periods to obtain its spring characteristics.

Table Of Physical Properties

	Rigidity (G) X10⁶	Elasticity (E) X10⁶	Temperature Coefficient Of E X10⁻⁶ per deg. F.	Max. Tensile Strength X10³ PSI.	Max. Working Stress (Tor.) X10³PSI.	Max. Working Stress (Bend.) X10³PSI.	Linear Expansion in./in./deg. F.	Rockwell Hardness	Density Lb./in.³	Resistivity 20 deg. C. Ω-cm./ft.	Heat Treatment Int. Stress Relief** (deg. F.)	Magnetic Properties
Iso Elastic	9.2	26	−20 to +15	170	40-60	90-100	4 X 10⁻⁶	C30-36	0.292	528	750	Slightly Magnetic
Beryllium Copper	6-7.5	16-18.5	−194	160-200	65-95	100-150	9.2 X 10⁻⁶	C35-42	0.297 ±0.01	9.8	Heat Treatable Alloy 600 F. For Hardening Only	Non-Mag.
Phosphor Bronze	6.25	15	200 to −222	100-150	50-85	60-110	9.9 X 10⁻⁶	B90-100	0.320	56.46	500 F.	Non-Mag.
Stainless Steel 18-8	10	28	.....	160-330	45-140	60-260	9.61 X 10⁻⁶	C35-45	0.290	92	600 F.	Mag.
Oil-Tempered Steel	11.5	30	−190 Approx.	155-300	80-130	120-250	6.6 X 10⁻⁶	C42-46	0.284	60	500 F.	Mag.
Music Wire	11.5-12	30	−190 Approx.	250-500	90-180	150-350	6.6 X 10⁻⁶	C42-46	0.284	70	470 F.	Mag.
Chrome Vanadium	11.5	30	−146	200-250	100-130	180-230	6.5 X 10⁻⁶	C42-48	0.284	.....	Varies	Mag.
Ni-Span-C	10	24-27.5	−10 to +10	90-200	.....	15-110	4.5 X 10⁻⁶	B70-C44	0.294	480-580	Heat Treatable Alloy 1100-1350 F. For Hardening Only	Mag.

** *Heat Treatment Is For Internal Stress Relief, Unless Otherwise Indicated*

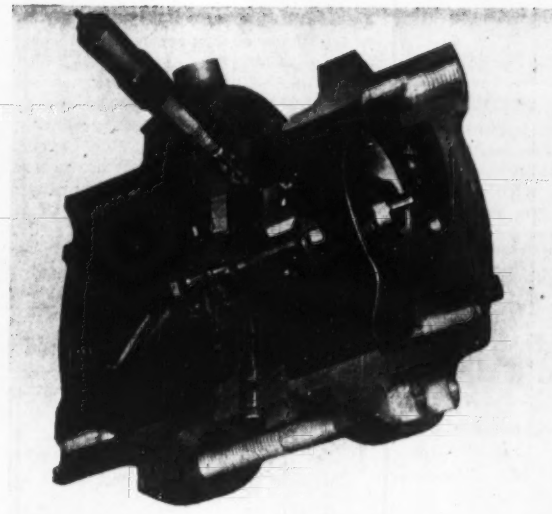

Fig. 1. Cutaway view of "Model 199" bellows unit of Barton flowmeter, showing precision range spring.

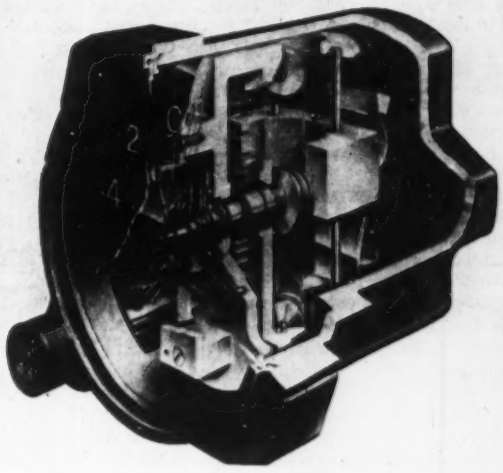

Fig. 2. Bendix accelerometer, showing typical application of temperature-compensated "Iso-Elastic" springs, which must have low hysteresis, drift, and temperature variation from minus 50 to plus 150 deg. F.

loading curves when plotting load versus deflection (Fig. 4).

Drift

An important characteristic of springs is a property called "drift." Whenever a spring is loaded continuously for a time it undergoes two types of deflection. The spring deflects immediately with application of load and appears to reach stability. If accurate measurements are made, however, it is found that a delayed deflection takes place (Fig. 5). This additional deflection may continue for minutes, hours, or days, depending on fiber stress of the spring material, or on the work hardening taking place.

A steel spring normally has a drift error of approximately 0.02 percent of deflection after one hour of continuous loading, and of 0.065 percent after 24 hours. The same spring, if made of "Iso-Elastic," would have a total error of less than 0.01 percent after 24 hours of continuous loading. Beryllium copper and Ni-Span-C materials have approximately the same drift error as "Iso-Elastic." However, beryllium copper changes considerably in strength with change in temperature.

Increase in temperature increases the drift rate, but complications arise in determining this amount because the modulus of elasticity changes with temperature for the vast majority of spring materials. This leads to the important property of the temperature coefficient of the modulus of elasticity.

Temperature Coefficient

The thermal coefficient of the modulus of elasticity determines the change in the rate of the spring that results from a change in temperature. Ordinary spring steel, for example, has a temperature coefficient of -190×10^{-6}/deg F., whereas specialized materials have lower temperature coefficients, as shown in the table. The sign preceding the thermal coefficient designates the direction of change; the "minus" sign designates a weakening of the spring with increase in temperature, the "plus" sign indicates that the spring stiffens with increase in temperature.

Space Requirements

When alloy materials other than steel are required, the usual high stresses that are used for steel springs must be reduced considerably to produce satisfactory designs. This means that springs of specialized alloys invariably occupy more volume than equivalent steel springs. Design engineers should allot as much space as possible wherever a spring of special material is specified.

Spring Design Calculations

For extension springs the equation for calculating stress is:

$$S_{max} = (P_{max})\ (CK)/0.4d^2 \quad (1)$$

where S_{max} is maximum stress in psi., P_{max} is maximum load in lbs., C is the spring index (mean diameter of coil divided by wire diameter), K is Wahl correction factor, and d is wire diameter in inches.

For calculating the number of active coils:

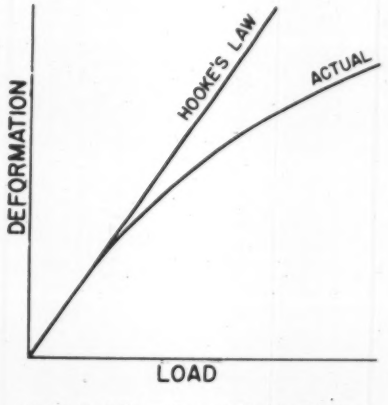

Fig. 3. Deviation of a spring metal from Hooke's law.

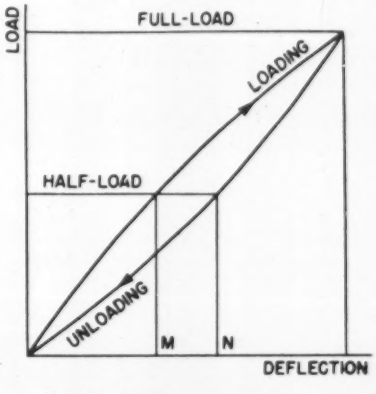

Fig. 4. Spring hysteresis curve.

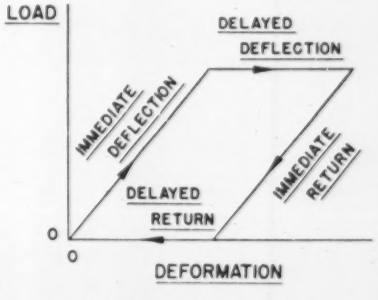

Fig. 5. Drift characteristic.

$$N_A = FGd/8PC^3 \quad (2)$$

where N_A is number of active coils, F is deflection in inches, P is applied load in lbs., and G is modulus of rigidity in psi.

For truly precision springs the best straight-line characteristic as well as the least possible hysteresis and drift errors are essential. In order to obtain the best straight-line relationship between load and deflection it is necessary to have as many coils as possible. Consequently, most precision springs are designed to use all available space to insure having the maximum amount of wire in the spring.

As an example in spring design, consider one of a series of range springs used in the Barton flow meter (Fig. 1). Space was limited, particularly for the outside diameter of the spring, and the active length in coil. The original specifications (Fig. 6) were as follows: Outside diameter: 0.312 inch (maximum); free active length in coil: 0.875 inch (maximum); solid length in coil: 0.593 inch (maximum); ends: two axial ends through center, each 0.375-inch long; maximum load: 2.08 lbs; maximum deflection: 0.275 inch; rate: 7.57 lbs. per inch.

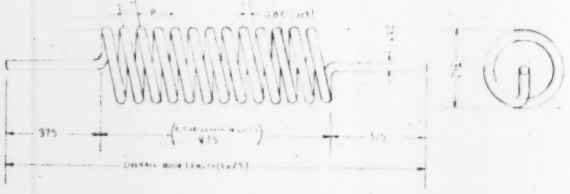

Fig. 6. Specifications of range springs used in Barton flowmeter.

Assuming a value of d (wire diameter), equations 1 and 2 can be solved for stress and number of coils. The stress, as so calculated, must not exceed the allowable working stress for the material specified. If it does, another value of d must be assumed until the stress is satisfactory. Likewise, the number of coils must be such that the free and solid length of coils are within the specified limits. Assuming a wire diameter of 0.037 inch, we have;

$$C = (O.D-d)/d$$
$$= (0.312-0.037)/0.037$$
$$= 7.45$$

and K = 1.20 (see following paragraphs for determination of K).

Hence, $S_{max} = P_{max}\ CK/0.4d^2 = 34{,}000$ psi. and $N_A = FGd/8PC^3 = 13.6$ coils.

From the table, the elastic limit of "Iso-Elastic" is 35 percent of the tensile strength. As the tensile strength is 170,000 psi., the elastic limit equals (0.35) (170,000), or approximately 60,000 psi. The calculated value of maximum stress of 34,000 psi. is, therefore, well below the limit.

The solid length (S_H) of coils equals: $S_H = (N_A-1)d = (13.6-1)\ 0.037 = 0.540$ inch, which is well below the specified limit of 0.593 inch maximum.

The free active length in coil (H_o) equals:

$$H_o = S_H - N_A\ (OBC)$$

where OBC = opening between coils.

$$0.875 = 0.540 - 13.6\ (OBC)$$
$$OBC = 0.025 \text{ inch.}$$

If the spring is made with 0.025 inch between coils, it meets the given specification of 0.875 inch free active length.

K Factor

The K factor (the Wahl curvature correction factor) is important. The equation for calculating this factor is:

$$K = (4C-1)/(4C-4) + 0.615/C$$

This stress factor is constant for each spring index, and has great effect on stresses in springs with indexes of less than 10. In the preceding example C = 7.45, hence K = 1.20.

If the K factor had not been used in the stress formula, the calculated stress would have been 28,200 psi. instead of the actual stress of 34,000 psi. In springs designed for high stresses, and with spring indexes less than 10, the Wahl factor plays an important part in good design.

Typical Applications

An interesting example of the use of "Iso-Elastic" springs occurs in the Barton flow meter (Fig. 1). The differential pressure developed across an orifice causes pressure difference in the two bellows chambers and is transmitted to a torque tube which twists an amount proportional to the pressure difference in the chambers. The resistance offered by the bellows and the torque tube is sufficient for pressure differences up to 20 inches of water. For greater differences a range-spring assembly is added. This unit (Fig. 1) consists of a group of tension springs connected between the outer end of the low-pressure bellows and the low-pressure housing.

Originally, stainless-steel range springs were used and the hysteresis at mid-point for normal temperature amounted to 0.19 percent of the differential-pressure range, and increased to 0.4 percent when the temperature rose to about 200 deg. F. When "Iso-Elastic" springs were substituted, hysteresis at the same load became 0.09 percent for normal temperatures and only increased to 0.2 percent at 200 deg. F., a reduction of approximately 50 percent.

Another improvement obtained with "Iso-Elastic" springs in the Barton flow meter concerns the zero-indicating reading. When stainless-steel springs were used it was found that an increase of 100 deg. F. caused the zero-pressure reading to drift by 0.15 percent of the differential-pressure range. When "Iso-Elastic" springs were substituted it became impossible to detect any zero shift for the same increase of 100 deg. F.

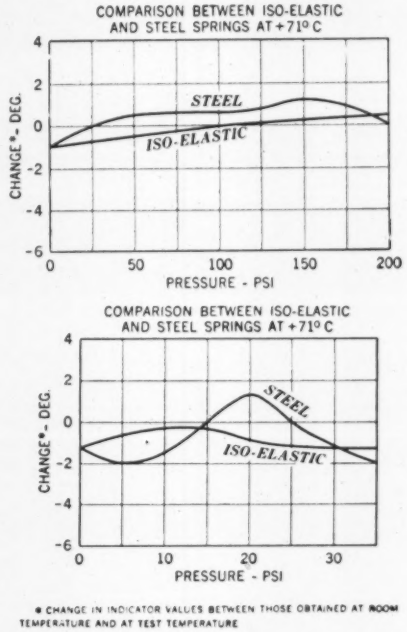

Fig. 7. Comparison of steel spring and "Iso-Elastic" spring at 71 deg. C. for Bendix oil-pressure transmitter (top), and fuel-pressure transmitter (bottom).

Another application of a precision spring is in the Eclipse-Pioneer "Magnesyn" pressure transmitter of Bendix Aviation Corp., used to check fuel pressure and to convey operating data to the flight engineer of aircraft. It must be unaffected by severe temperature changes. Illustrated in Fig. 7 are comparison curves resulting from tests on low-pressure and fuel-pressure transmitters making use of both steel and "Iso-Elastic" springs. By using "Iso-Elastic" for the calibration spring, instrument error was reduced to within one percent of the full-scale value over the entire range.

Accuracy of precision instruments depends on proper choice of springs. Instrument designers must take into account the maximum deviation allowed for straight-line characteristics, maximum hysteresis and drift errors to maintain accuracy requirements for the instrument, and maximum error allowable due to temperature changes. These factors determine the type of spring material selected and also the design for the required springs.

Journal of the S C M A . . .

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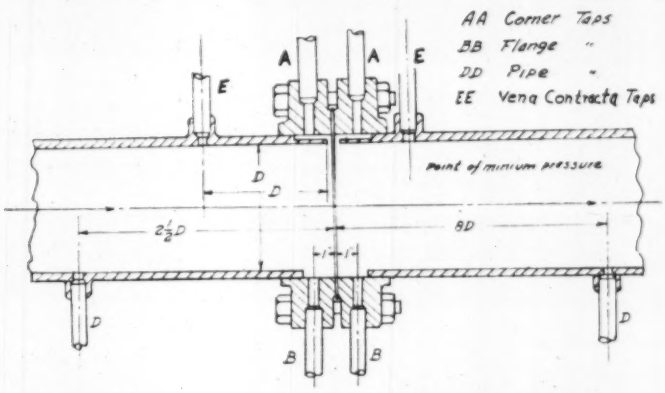


Fig. 1. Orifice taps, showing corner, flange, pipe, and vena-contracta taps.

Flowmeter Engineering

by L. K. SPINK and W. H. HOWE
The Foxboro Company

Head-type flow-rate meters will continue to lead the field. Important factors in use of such meters include (1) choice of primary element—orifice, Venturi tube, flow nozzle, flow tube, pitot tube, centrifugal element, or special element—(2) choice of orifice taps—corner, flange, vena-contracta, or pipe taps—(3) Reynolds-number correction, and (4) choice of differential-pressure instrument—wet or dry. Also discussed are the new electro-magnet, sonic, and mass flowmeters.

FLOW-RATE meters comprise all flow-measuring devices where the flow is continuous, as contrasted to displacement meters which measure and totalize discrete units of fluid. The *head meter*, a subdivision of flow-rate meters, uses a primary element which creates a difference of pressure, or *differential head*, which depends on the velocity and density of the flowing fluid.

In general, a flowmeter consists of two units—(1) the primary element which converts the fluid flow into a differential pressure or force, and (2) the meter which indicates, records, or controls the fluid flow.

HISTORY

Although the Romans used an orifice meter for measuring the quantity of water delivered to householders, the basic principle of the modern head meter was discovered by Venturi about 1791. Clemens Herschel developed the basic theory and the modern Venturi flowmeter, and worked out considerable coefficient data about 1887. However, the major developments in flow metering have occurred in the twentieth century, spurred by large-volume fluid measurements in natural-gas, water, sewage, and power-plant applications. The development of rate-of-flow meters has been spurred also by the increasing use of rate-of-flow measurement as a basic control function in chemical and petroleum processes. The economy and reliability of the head-type meter has brought it to the fore. In turn, this widespread use has spurred the development of accurate coefficient data covering a wide range of conditions, further improving accuracy and reliability.

June Meeting: Thursday, the 17th, Rio Hondo Country Club, Downey, Calif.

Feature: Charles G. Laspe, Shell Oil Co., will give a paper on "Compressor Speed Control—Reciprocating and Centrifugal."

PRINCIPLES

Head meters are based on the conversion of energy from one form to another by the primary element. For *liquids* this conversion is simply from kinetic energy (velocity) to potential energy (pressure). In conventional head meters, the entire stream is affected so that an average measurement is obtained. With liquids, the pressure difference across an orifice or Venturi tube is a function of the velocity, density, and viscosity of the flowing stream.

In measurement of *compressible gases*, the internal energy of compression also must be considered in the energy conversion. It is possible to compute from theory the coefficient of a Venturi tube or flow nozzle for gas flow. For an orifice, however, the indefinite area of the jet (vena contracta) makes theoretical computation difficult. In practice, hydraulic formulae are used with experimental corrections based on test results.

PRIMARY ELEMENTS

The thin-plate square-edged orifice is the most common primary element. Under some conditions the Venturi tube has marked advantages; the flow nozzle has merit in specific cases. The Pitot tube, the centrifugal head meter, and the frictional head meters operate successfully under certain conditions. Any device which will produce a pressure difference dependent upon flow may be used, if properly calibrated

and maintained. However, the wealth of available data on performance and coefficients of the standard devices makes their use preferable.

Thin-plate Square-edged Orifice

The thin-plate square-edged orifice is easy to install, to inspect, and to replace if damaged or if a change of coefficient is desired. There is considerable economy in first cost both with regard to the orifice itself and to its mountings. The orifice is readily reproducible. As the characteristic depends solely on the ratio of diameter of the orifice to the diameter of the pipe, it is simple to produce a unit of any desired coefficient (within reasonable limits) and to check in the field that the desired ratio exists.

Supplementing these basic advantages is the wealth of test data on the thin-plate square-edged orifice which has established empirical test data for a wide range of operating conditions. The accuracy of the coefficients has been verified by independent test procedures. Analysis of the data shows that under suitable conditions the measurement with the thin-plate square-edge orifice is as reproducible as any other primary measuring device.

Orifice Taps. There is considerable choice in location of the taps which measure the differential pressure across the orifice plate. *Corner taps, flange taps, vena-contracta taps,* and *pipe taps* are used (Fig. 1). A limiting criterion in selection of the tap location is to avoid regions of large turbulence and high pressure-gradient. The interval from ¾ of a pipe diameter to 3 diameters downstream from the orifice is unfavorable in this respect.

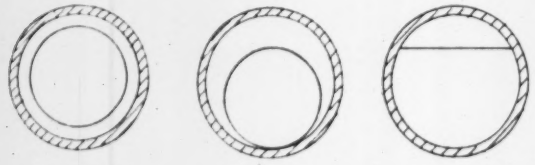


Fig. 2. Orifice types—concentric, eccentric, and segmental.

In general, *flange taps* are desirable and are the most widely used in this country. Flange taps are readily available for inspection. They are accurately located by the manufacturer and not subject to human error in location. As they are symmetrical with respect to the orifice, they are suitable for measurement of reversing flows. The geometric dissimilarity on different pipe sizes is unimportant because this dissimilarity is allowed for in the coefficient. The coefficients and limitations of flange taps are established with greater precision than for other tap locations. A limitation on flange taps is that on high diameter-ratios on small-sized pipe (2 inches and less) the tap location on the downstream side is in the borderline of the unfavorable region of high turbulence; for this condition flange taps are not recommended.

Corner taps have been used widely in Europe. Owing to their location immediately adjacent to the plate, they are more subject to dirt, freezing, and accumulation of foreign material which tends to collect in the "corner." Corner taps are more affected by plate and gasket thickness and by upstream disturbances than are other tap locations. Their use is impractical in some modern high-temperature high-pressure piping construction. With the exception of the high diameter-ratios on small pipes, they have no appreciable advantage over the flange taps and are subject to definite disadvantages, as well as the fact that the coefficient data are not as good as for flange taps.

Vena-contracta and pipe taps have been used considerably. The *vena-contracta* tap is one diameter upstream from the orifice and at a point downstream where the pressure is a minimum. Standard *pipe taps* are 2½ diameters upstream and 8 diameters downstream. For minimum pressure-gradient and minimum turbulence, pipe-tap locations are optimum. However, the gain in accuracy compared with flange taps is unimportant. The fact that the point of minimum pressure downstream varies with the orifice diameter, and to a certain extent with the flow velocity, puts some uncertainty into this location. Pipe taps are affected by any roughness or irregularity in the surface of the pipe. Vena-contracta taps and pipe taps are inspected less easily than flange taps. The pipe taps require a considerably greater straight run of pipe for accurate measurement. Finally, because of "pressure recovery," the pressure difference applied to the meter with flange, vena-contracta, or corner taps (with a given orifice) is appreciably greater than the differential applied to the meter with pipe taps.

Recent work has indicated that a further pressure recovery can be obtained with corner taps or flange taps by use of a second orifice equal in diameter or a little smaller than the primary measuring orifice and located downstream a little beyond the normal vena contracta, or point of minimum pressure. In one set of tests with a 100-in. meter the pressure drop with a single orifice was 60 inches, whereas the pressure drop with the double-orifice construction was reduced to 40 inches. (See "Flow Through Two Orifices in Series," Rohsenow, Fink, and Polis, ASME paper 51-A-87).

Eccentric and Segmental Orifices. Eccentric or segmental orifices (Fig. 2) are used frequently where there are solids in suspension in liquid, where there is condensate in steam, or where vapor is carried in a liquid flowing stream. These orifices allow passage of material which would normally back up behind a concentric plate. (Where there is a serious tendency toward clogging, Venturi tubes are employed.) The segmental or eccentric type often is used with high d/D ratio in small lines. As the amount which the orifice plate extends into the pipe at maximum is greater for a given coefficient than is the case in the concentric orifice, the permissible location of the downstream tap is less limited. There is a belief that eccentric and segmental orifices are superior in accuracy and reliability for large beta ratios. However, at present there is no test data to support this. In addition, the coefficient data on eccentric and segmental orifices is not as well established. There is some good data on coefficients for 4-in. and 6-in. pipe sizes in the ASME paper by Beitler, published in 1940, but precise coefficient data for these types of orifice plates are less complete than for the concentric type.

Small Orifices. Down to 2-in. pipe size, orifice data is accurate and reliable. For smaller diameters certain considerations render these measurements less reliable.

Data taken on 2-in. and larger orifice plates indicate that for standard coefficient data to hold, the plate should be not greater in thickness than ⅛ of the diameter of the orifice, not greater than 1/30 of the diameter of the pipe, and not greater than ¼ of the distance which the orifice extends into the line from the pipe wall. If these criteria are departed from to any major extent, there is a tendency for the device to have the characteristic of a short tube. At high flows this short tube may have the characteristics of an orifice, whereas at low flows the flow becomes "broomy," with a change of as much as 25 percent in the coefficient between these two conditions. The limitations imposed by the above criteria can be visualized by the fact that for an orifice plate with a hole 1/32 inch in diameter, the plate should not exceed 4/1000 inch in thickness. Considerable improvement can be obtained by beveling the downstream side of the orifice opening to give essentially a sharp edge. Under favorable conditions an orifice plate of this design can be useful down to a 1/32-in. bore. (See ASME paper 50-A-64 by Grace and Lapple).

An additional limitation on small orifices is the fact that at small flows the Reynolds number decreases correspondingly so that viscosity effects become of increasing importance. Hence viscosity corrections become more important. Many liquids on which the viscosity effect can be neglected in larger-sized orifices become critical when the orifice size is small. This effect is further heightened by the fact that flow velocities in small tubes are often less than for larger pipes. To a certain extent it may be possible to overcome some of these Reynolds-number effects by use of special orifice profiles. This will be discussed later.

Venturi Tubes

Venturi-tube installations are usually more expensive than installations with orifice plates. Under some circumstances the added expense is justified. Where large quantities of fluid are being pumped, the power required to overcome the pressure drop of the measuring element may be important. The greater pressure recovery obtained by a Venturi tube, with corresponding reduction in loss of head, may result in power saving which will pay for the added cost of the Venturi tube. A second major advantage of the Venturi tube lies in its essentially smooth inner surface. For solids in suspension, for fluid catalyst measurements, for clay slurries, for paper stock, for sewage and many similar applications, build-up of material at an orifice plate may alter the characteristic and make measurements inaccurate. The Venturi is generally used for such service. A final advantage of the Venturi tube is the fact that it is less affected by upstream disturbances than is an orifice, and hence does not require as long a straight run of upstream pipe.

The modern Venturi tube (Fig. 3) is essentially the form designed by Clemens Herschel. The recovery tube is designed with a one-in-ten taper—that is, the diameter increases one inch for each 10 inches of length, giving a 20-to-1 slope on each side. Tests indicate that either steeper or less-steep slopes result in reduced pressure recovery. Other contours have been tried with no apparent improvement. Where some sacrifice in total recovery can be tolerated, a truncated recovery cone can be used; as most of the pressure recovery occurs in the high-velocity small-diameter section,

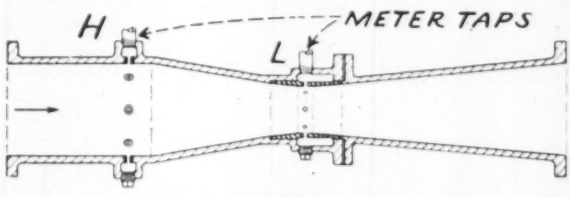


Fig. 3. Standard Venturi tube.

the truncated recovery cone realizes a large part of the pressure recovery with appreciable saving in over-all length. Any build-up of solids at the end of the truncated cone is far from the measuring throat and has negligible effect on the coefficient.

Venturi tubes in small sizes have been used successfully. The unfavorable shape factors which limit orifices do not affect Venturi tubes. However, the same Reynolds-number effects, requiring increased correction factors for viscosity as the size decreases, do occur. Further, the effects of surface finish and irregularities tend to increase as size decreases. As was mentioned, the ten-to-one taper is optimum for pressure recovery. However, for measurement, the recovery cone angle is of negligible importance except that a 20- to 30-degree recovery cone tends to produce instability under certain flow conditions and should be avoided.

Flow Nozzles

A flow nozzle (Fig. 4) is essentially a Venturi tube without a recovery cone. At first glance at the coefficients, it appears that a flow nozzle has a better pressure recovery than an orifice plate. However, because of the fact that a flow nozzle with the same diameter as an orifice plate and located in the same line develops only about two thirds as much head, the effective pressure recovery for the same head on both is about equal. In other words, in order to produce the same pressure difference, a flow nozzle should develop the same maximum velocity as the orifice plate, and so its diameter should equal the vena-contracta diameter of the orifice, which is considerably smaller in diameter than the orifice itself. For high-velocity streams this characteristic favors the flow nozzle, because for high-velocity streams a high beta ratio is indicated; for a given differential pressure the beta ratio of the flow nozzle is more favorable than that of the orifice. With regard to solids in liquid flows, gas in liquid flows, and liquid in vapor flows, the flow nozzle is considerably better than the orifice. However, it is not as good as the full Venturi tube, especially if pipe taps rather than throat taps are used.

For a flow nozzle the upstream pressure tap is taken one pipe-diameter upstream of the beginning of the nozzle. The downstream tap may be taken either at the throat of the nozzle or at a point about ½ pipe-diameter downstream from the nozzle. For most services the pipe tap is recommended because for the throat tap small irregularities in the surface where the tap intersects the throat can produce appreciable errors in measurement. Throat taps are less affected by material in suspension in the flowing stream. Flow nozzles should be designed with a relatively short length of uniform-diameter throat because if the length-to-diameter ratio of the uniform section is appreciable, considerable error in measurement may result.

Other Head-meter Primary Elements

Flow Tubes. A flow tube (Fig. 5) consists of a spool-shaped section, usually from one to two diameters in length, with two groups of nozzles spaced around the inner periphery. One group points upstream and one downstream. The former group is connected through its piezometer ring to the high-pressure side of the meter; the latter group is connected to the low-pressure side.

As the flow tube uses impact pressure, the contraction from main to throat can be made as small or as large as desired. Head losses are thus minimized and a higher differential is produced than is produced by nozzles or Venturis. Flow tubes are used for many industrial head-meter services. A promising new flow-tube design is the Dall flow-tube developed by Kent in England.

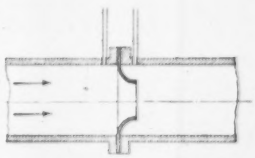


Fig. 4. Flow nozzle, or rounded-approach orifice.

Pitot Tube. The Pitot tube (Fig. 6) is an important laboratory and test mechanism for flow measurement. On the other hand, because of the low head which it produces, because of its tendency toward plugging, and because of its high susceptibility to error due to change in the flow pattern across the diameter of the pipe, it has not been used to any major extent as a primary element for industrial service.

Centrifugal Elements. If a fluid flows in a curved channel, the centrifugal action produces a difference of pressure between the outside of the curved pipe and the inside. A simple elbow with taps is the simplest possible centrifugal-type device. In hydraulic turbine design, taps at the inside and outside of the scroll-case (Winter Kennedy taps) are commonly used for the measurement of flow. In general, individual calibration of each metering unit is required. Obviously, for precise measurements of this type, the curved tube should have a smooth inner surface with minimum irregularity in the transition from straight to curved pipe section. On the other hand, simple elbow taps have been quite effectively used as flow indicators where accuracy of measurement was of secondary importance.

Other Special Elements. Special shapes of orifices and Venturi tubes have been commonly employed. In many air-flow measurements, rectangular Venturi tubes in rectangular ducts have been successfully employed. In practically all of these special shapes, calibration in place is required because coefficient data are not available.

For small-flow measurements, some experimental work has been done taking the pressure drop across a porous plug. This *viscous-flow technique* is obviously suitable only for clean fluids. However, it does have the advantage that the pressure drop is linear with flow rather than being proportional to the square of the flow; hence the device has a wider effective rangeability. This work is described in a paper by Souers and Binder, "Linear Resistance Meters for Liquid Flow", ASME Paper 51-A-57, and another paper,

"Study of Linear Resistance Flow Meters" by Fleming and Binder, ASME Paper 50-A-37. (See also "Use of Capillary Tubing for Flow Measurement" by Mahood and Littlefield, *Instruments and Automation*, March, 1954, Page 460.)

Reynolds Number

In 1883 Osborn Reynolds published a paper in the "Philosophical Transactions of the Royal Society," describing a dimensional analysis of flow coefficients and giving a single number which in effect represents the ratio of inertia effects to viscous effects. This coefficient, the "Reynolds number," is an important criterion in many flow calculations. Actually, the Reynolds number equals velocity times pipe diameter times fluid density, all divided by the absolute viscosity of the fluid.

For high Reynolds numbers, the viscosity effect usually can be ignored. As the Reynolds number decreases, the viscosity effect becomes of increasing importance. A major correction factor at low Reynolds numbers is required. As the viscous effect increases—that is, at low Reynolds numbers—the orifice coefficient increases, whereas both the Venturi and the flow-nozzle coefficients decrease. That is, for Venturi tubes and flow nozzles, the total pressure drop increases as the viscosity increases. However, for orifices, down to low Reynolds numbers, increase of viscosities tend to increase the diameter of the vena contracta, thereby reducing the maximum flow velocity and the pressure drop. This characteristic has led to attempts, particularly in Europe, to produce a primary element between a flow nozzle and an orifice, one whose coefficient would not be affected by viscosity. The same characteristics which reduce the effect of velocity also reduce the effect of surface irregularities, dirt accumulations, and other factors adjacent to the measuring surface. Two forms have been tried with reasonable success—the quadrant orifice and the semicircular orifice (Fig. 7).

A design having a semicircular profile has been the subject of further test work in England. The original calibrations were performed by E. Schmidt in Germany. Tests were run by Leys and Leigh (see *Instrument Practice*, April 1950, United Trade Press, Ltd., 24 Bride Lane, Fleet Street, London, E.C. 4, p. 289-294) to determine the accuracy with which orifices with semicircular profile could be duplicated. Five semicircular profile orifices of 0.4-in. diameter for 2-in. brass pipe were manufactured in different machine shops. The thickness of each was approximately 0.25d and the radius of curvature 0.125d, making both plate surfaces tangent to the semicircle.

The test results are shown in the table:

Discharge Coefficients of Semicircular-Profile Orifices

Orifice	*Material*	*Discharge Coefficient (C)*	*R_d min. for Constant C*	*Deviation of C from 0.782 (%)*
Original	Brass	0.800	280	+2.25
A	Stainless steel	0.794	296	+1.53
B	Brass	0.782	340	0
C	Brass	0.782	324	0
D	Brass	0.774	320	−1.02

Differential-Pressure Instruments

Choice of instrument used to measure the differential pressure is simpler than the choice of primary element because the catalog data of instrument manufacturers provide accurate specifications. Differential-pressure-measuring instruments fall into two major classes—wet and dry.

Wet-type Meters

The U-tube manometer is the basic wet-type instrument; it is the most simple and probably the most accurate method of measuring a differential pressure. Its accuracy is limited only by (1) the accuracy with which the gravity of the measuring liquid, usually mercury, is known, (2) the accuracy of the scale, and (3) the accuracy of observation. Care in measuring is necessary to avoid error introduced by the meniscus. Temperature corrections are readily determined and applied.

The principle of the U-tube manometer is applied to the float-type differential instrument in which the level in one leg of the manometer is measured by a float, with the motion of the float transmitted to the pointer or control mechanism. As the level in only one chamber is measured, it is necessary that the diameter of the two chambers be uniform. A large float operating through a long stroke is desirable both from the point of view of providing adequate power to overcome possible frictional effects and to minimize other sources of error.

An important characteristic of the head meter is the inherent square-law characteristic. As the differential pressure varies as the square of the flow, 50-percent flow produces 25-percent full-scale differential pressure; 25-percent flow produces only 6-percent differential. Crowding at the lower end of the scale appears, with readability of flows of less than 25 percent seriously affected.

Uniform-flow-scale meters are more readable at the low end; however the improvement is primarily in readability and not in accuracy. Note that 10-percent flow develops only 1-percent full-scale differential; at 14-percent flow, the differential pressure is 2-percent of full-scale value. Thus if the zero of the meter is in error by ½ of 1 percent, the flow measurement for say 12-percent flow is in error by 2-percent of the full-scale value, and in error by 16 percent of the actual flow. As the zero value on the uniform-flow-scale meters is hard to determine with high precision, absolute accuracy at low flow is limited.

Where wide-range high-accuracy flow measurement is required, it is common practice to use two meters—a 100-in.

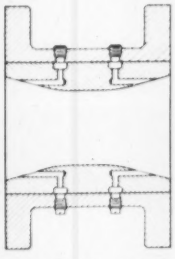


Fig. 5. Flow tube. (Foster Engineering design).

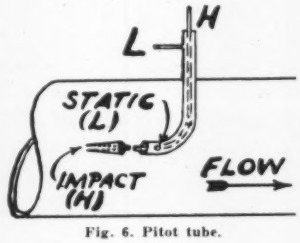


Fig. 6. Pitot tube.

and a 20-in. meter—connected across the primary element; the 20-in. meter is used for flows of less than 40-percent maximum value. The 20-in. meter must, of course, be protected so that it is not upset when a 100-in. differential pressure is applied from the orifice. For even wider ranges it is possible to use a large and a small orifice in parallel, and either manual or automatic means for switching from one orifice to the other.

In addition to the standard float-type differential meter described, Ledoux-bell-type meters and ring-balance meters are frequently used wet-type meters. The Ledoux bell provides a uniform flow scale; the ring-balance meter is readily characterized to produce a uniform-flow-scale effect. In general, the problem of wide-range-flow measurement is the same with these as with the float type, being based on the squared characteristic of the primary element.

Dry Meters

The second major type of flow meter is the so-called dry meter, in which the differential pressure from the primary element is applied to a diaphragm or bellows to produce a force or motion proportional to the differential pressure. There are two classes of dry meters—the deflection and the force-balance type.

The *deflection type*, with motion of the diaphragm or bellows proportional to the differential pressure, is used where a direct indication or record of the flow is desired. The deflection-type unit is also employed frequently with an electrical measuring unit; a comparatively small motion of a diaphragm moves a magnetic slug in a balanced coil

structure, to produce an electrical voltage or reactance unbalance proportional to the diaphragm deflection. This structure can be made to operate with the slug inside a stainless-steel tube and the coil outside the tube, thereby providing a satisfactory seal. Seals of this type have been tested under pressures as high as 40,000 psi. The motion of the slug can be small; total motions of less than ten thousandths of an inch are used in special applications.

In the *force-balance* type of meter the force exerted by the differential pressure on the diaphragm or bellows is opposed by a pneumatic force operating on a pneumatic bellows. A null detector measures the resultant motion and controls the air pressure in the pneumatic bellows to balance the differential pressure from the primary element. The pneumatic pressure then becomes a measure of the differential pressure and is transmitted to a standard pneumatic receiving instrument.

Dry meters generally have uniform scale; various square-root extraction devices have been used. However, these have the same basic errors as for wet-type meters.

Other Flowmeters

Three new and radical departures in flowmetering practice will be mentioned briefly to indicate current trends.

Electro-magnetic Flowmeter

The electro-magnetic flowmeter is based on the fundamental electric generator principle—if a conductor moves

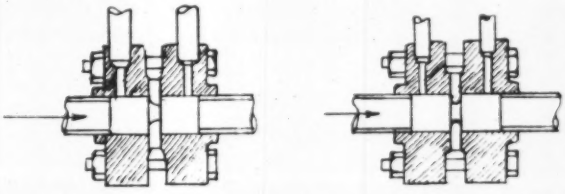


Fig. 7. Quadrant and semicircular orifices.

in a magnetic field, a voltage is generated in the conductor proportional to both the strength of the magnetic field and the velocity at which the conductor moves. For flow measurement the conductor is any liquid having a *measurable conductivity.* A uniform magnetic field is developed by a permanent magnet or an electro-magnet located outside the pipe. The generated voltage is measured by a pair of insulated electrodes in opposite sides of the pipe on an axis perpendicular to the magnetic field. With a uniform magnetic field, the voltage between the electrodes is proportional to the velocity of the fluid flow. The system has the advantage that the fluid flows in an unobstructed clean pipe with no reaction on the flowing fluid. This method has been employed successfully in measuring the flow of liquid sodium, with the electrodes taken from the stainless-steel pipe without breaking the inner pipe surface. In this application the liquid is highly conductive, and a direct current or permanent magnet can be used to generate the field.

For water-based liquids, the d-c. potential which would be produced by a unidirectional magnetic field would cause polarization at the electrodes; therefore, an a-c. magnetic field, usually 60 cycle, is employed. The measuring system which measures the potential between the electrodes must have an impedance high compared to the impedance of the measured fluid. This places some limitation from the practical angle on the conductivity of the fluid itself. Ordinary tap water with a conductivity of 50 micromhos per cubic centimeter has been measured easily. However, when the fluid conductivity is one micromho or less, the measuring problem is more difficult. The method is limited to liquids. In some cases it has been possible to obtain measurements of normally nonconducting fluids by addition of trace quantities of materials which rendered the liquid conductive. The measurement is inherently linear. A wide range of flow can be covered with high accuracy by use of a measuring instrument which has a wide range of measuring voltage. The rate of response of the measurement is great, limited only by the frequency of the magnetic field. Where extremely high response is required, higher frequency magnetic fields have been used to keep the exciting field frequency above the frequency response of the required measurement.

Electro-magnetic flowmeters are at present much more expensive than head-metering equipment. However, as development progresses, the cost should decrease. For applications such as sanitary flows of food products, for abrasive slurries, and for highly corrosive and erosive materials, the over-all cost may be favorable compared to other methods.

Sonic Flowmeter

The velocity of sound in a fluid in motion is the resultant of the velocity of sound in the fluid at rest plus the velocity of the fluid itself. If the velocity in the direction of flow is compared to the velocity counter to the direction of flow, the velocity in the fluid at rest can be cancelled out, leaving a result which is an indication of velocity of the fluid flow. Theoretically, this provides a simple and straightforward method of flow measurement. However, difficulties are caused by the relatively high velocity of the sound in the fluid compared to the velocity of the fluid. Electronic techniques have made it possible to obtain measurements of low rates of flow in reasonably short tube lengths. By using a ring-type crystal vibrator surrounding a plastic tube both for transmitter and receiver, it is possible to measure fluid velocity without any physical contact with the liquid. The tubing can be teflon or equivalent, and can be reinforced if necessary to withstand reasonable working pressures. This method probably provides the most complete isolation between the measuring element and the measured liquid of any system so far designed. Present designs of the electronic system are not simple. However, most of the techniques are straightforward; operation and maintenance should not be difficult. This method lends itself particularly to small flows because the transmission through a relatively small column of fluid is adequate. As with the electromagnetic flowmeter, the present cost is high, but development may reduce this to a competitive situation for special measurements.

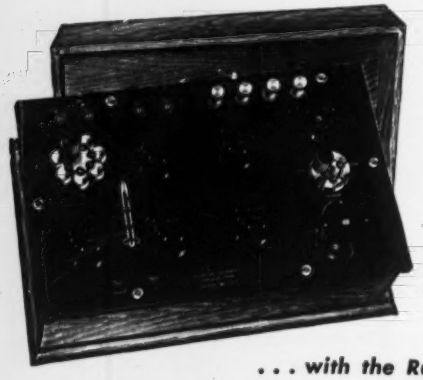
Mass Flowmeter (Coriolis Effect)

A third new type of flowmeter differs greatly from the two previously described in that it introduces more mechanism into the flow line. Two versions have been designed. In one, a fluid flow is passed outwardly through a radial-flow turbine wheel rotating at constant speed, with the torque necessary to rotate the turbine wheel measured as a function of the flow velocity. The second is one in which a constant-speed turbine wheel spins the flowing liquid, after which the liquid passes into a second, virtually stationary turbine wheel which absorbs the rotating energy; the torque developed by this absorption is a measure of the total flow. In either instrument the torque measured depends entirely on the mass of the fluid being handled and is independent of temperature, viscosity, density, and other extraneous effects. The torque is a direct and linear variable with flow. Both systems have used electrical torque-measuring devices, with the flow appearing directly on a suitable standard electric indicator or recorder. Although the measuring mechanism appears somewhat complicated, requires rotating seals, and might be clumsy for large flows or high pressures or "difficult" liquids, it appears to have application (1) where mass flow is desired, (2) on liquids whose viscosity and density vary unpredictably, and (3) especially where the range of flow rate varies over a relatively wide range. Devices of this type appear to have their maximum field in the measurement of clean liquids in moderate quantities where a large number of meters of the same type are required. A specific example is in the testing of jet engines.

Conclusion

The use of flow-rate meters of all types is continually increasing. The simple head meters probably will continue to lead the field because of economy, simplicity, and reliability. The new types will be used increasingly where the added complications and expense are justified because of special measurement conditions.

Precise
TEMPERATURE MEASUREMENTS



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Continued from page 778

slower, or the same sped as B. Therefore, the differential spider and the output shaft will turn forward, reverse or stand still and carry full torque at all speeds including zero.

Constant flow-rate.—By using a synchronous electric motor and a speed changer to drive the leading side of the differential, a precision governor is obtained. The following side is driven by the machine to be governed and the differential control lever is linked to its speed control. This provides an isochronous governor which will hold the machine at set speed regardless of changes in load. A governor of this type may be applied to anything which rotates and which is subject to infinitely-variable control. For example, it can become a constant rate flow controller for liquids by driving the following side from the spindle of a positive-displacement meter in the liquid line. The differential control lever is attached to a flow control valve in the meter line.

Proportional Control.—Now, by combining the constant flow control with the leading element system, an arrangement capable of simultaneously controlling the flow-rates of several liquids is obtained. Fig. 11-7 is a schematic layout of Proportioneers, Inc. "Automatic Continuous Volumetric

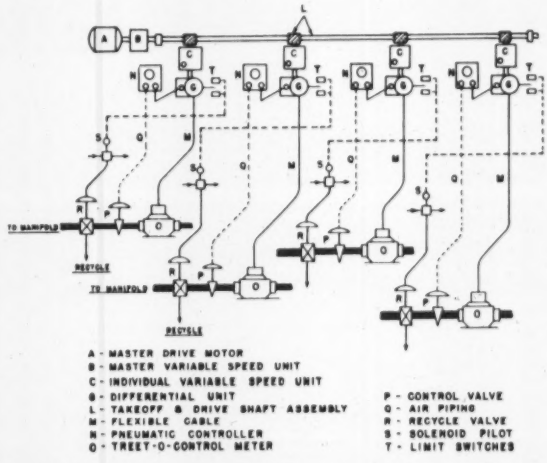
A - MASTER DRIVE MOTOR
B - MASTER VARIABLE SPEED UNIT
C - INDIVIDUAL VARIABLE SPEED UNIT
G - DIFFERENTIAL UNIT
L - TAKEOFF & DRIVE SHAFT ASSEMBLY
M - FLEXIBLE CABLE
N - PNEUMATIC CONTROLLER
O - TREET-O-CONTROL METER
P - CONTROL VALVE
Q - AIR PIPING
R - RECYCLE VALVE
S - SOLENOID PILOT
T - LIMIT SWITCHES

Fig. 11-7. Automatic continuous volumetric blender controlling flow rates of four products in exact ratio.

Blender" which utilizes this system. Synchronous motor A driving through integrator B (speed changer) to line shaft L is used as a master speed reference. By adjusting the setting of integrator B, the speed of master lineshaft L can be changed, which produces a simultaneous and equal change in the input speed to each of the secondary integrators C. To illustrate the control of one component, assume that the master integrator B is set to turn the leading line shaft at 100 rpm. and that the secondary integrator C has been set to drive the leading side of synchronizer G at 10 rpm. The following side is driven through flexible cable M connected to the spindle of meter O. If meter O is geared to pass one gallon per spindle revolution it will have to rotate at 10 gpm. to balance the differential in synchronizer G and hold it in a neutral position. Should the meter pass more or less than exactly 10 gpm. the differential will move from its neutral position and unbalance the sensitive element in the air controller N which will reposition control valve P until the 10 gpm. rate is restored. By adjusting the secondary integrator C, the controlled rate of flow through the meter and valve may be set for any value relative to the rotation of the master line shaft. Therefore, the ratio of the various components is established in terms of percent by calibrated dials on each of the secondary integrators and the over-all rate of total blend is fixed by the master integrator which drives line shaft L. Over-all errors in actual installations are said to average less than 0.5 percent, independent of changes in head, temperature and viscosity.

Events...

May 23-28
Second Annual Meeting, A.S.T.M. E-14 Committee on Mass Spectrometry, Jung Hotel, New Orleans, La. For information write William Priestly, Jr., Standard Oil Development Co., P. O. Box 121, Linden, N. J.

May 24-26
National Telemetering and Remote Control Conference and Exhibit, Morrison Hotel, Chicago, Ill. For information write Jerry Roedel, c/o Pullman-Standard Car Mfg. Co., 1414 Field St., Hammond, Ind.

May 24-27
School of Public Health and Institute of Industrial Health Symposium on Instrumentation, University of Michigan, Ann Arbor, Mich. For information write Marian N. French, Institute of Industrial Health, University of Michigan, Ann Arbor, Mich.

May 24-27
Fourth Annual Research Equipment Exhibit, National Institutes of Health, Bethesda, Md. For information write Supply Management Branch, National Institutes of Health, Bethesda, Md.

June 9-11
Eighth Annual Convention, American Society for Quality Control, Kiel Auditorium, St. Louis, Mo. For information write U. C. Gramsch, P. O. Box 4436, Wade Station, St. Louis 15, Mo.

June 12
Symposium on Instrumentation Education. University of Illinois. Co-sponsors ISA and ASEE. For information write Prof. G. R. Peirce, Dept. of Electrical Engineering, University of Illinois, Urbana, Ill.

June 13-18
Annual Meeting and Exhibit, American Society for Testing Materials, Sherman Hotel, Chicago. For information write R. Painter, 1916 Race St., Philadelphia, Pa.

June 16-18
Committee on Vacuum Techniques High Vacuum Symposium, Berkeley Carteret Hotel, Ashbury Park, New Jersey. For information write Committee on Vacuum Techniques, P.O. Box 1282, Boston, Mass.

June 20-25
"Atoms for Peace" Exposition in conjunction with Nuclear Engineering Congress at the University of Michigan, Ann Arbor, Mich. Sponsored by Nuclear Engineering Div., AICE. For information contact C. M. Sliepcevich, Chairman, 3030 Rackham Bldg., Ann Arbor, Mich.

July 6-10
Joint Commission on Electron Microscopy of International Council of Scientific Unions. For information write F. W. Cuckow, Secretary General of Commission, Chester Beatty Institute, Royal Cancer Hospital, Fulham Road, London, S. W. 3, England.

July 8-12
Convention on Industrial Electronics, Christ Church, University of Oxford, England. For information write British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1, England.

Sept. 13-25
Instrument Society of America First International Instrument Congress and Exposition, Commercial Museum and Convention Hall, Phila. Contact Richard Rimbach, Mgr., 845 Ridge Ave., Pittsburgh 12, Pa.

November 29—December 2
First International Automation Exposition, at the Coast Artillery Armory, New York City, N. Y. For information write First International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

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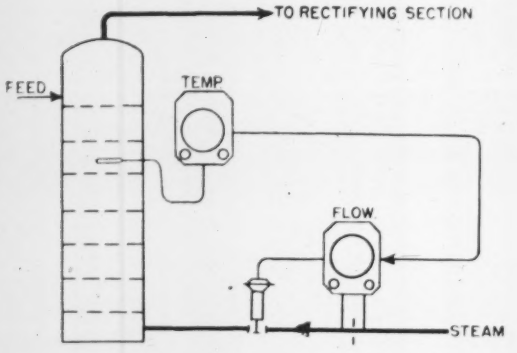
Briefs . . .

Cascade Control Systems

Cascade control is not precisely defined, but it generally involves at least two controllers interconnected so that one varies the set point at which the other controls. Each measures a separate but related variable.



Cascade control on stripping column in which live steam entering bottom is regulated by equilibrium temperature at some point in column. System allows maximum and minimum limits to be set more accurately than by stops on valve travel.

There seem to be four main reasons for the existence of cascade control systems. They may (1) maintain a desired relationship between variables, (2) accurately limit a secondary variable, (3) reduce load changes, non-linearities, and discontinuities near their source, and (4) improve the control circuit to reduce effective time lag. (*From new 28-page issue (Vol. 6 No. 3) of "Taylor Technology," Taylor Instrument Cos., Rochester 1, N. Y.*)

For this literature circle **401** on inquiry card.

Large Magnetic Drum

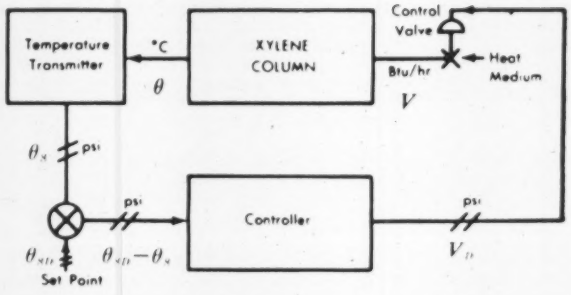
Magnetic drums have recently become popular as a way of storing information for electronic computers. Their greatest drawback, however, is lack of large storage capacity. Exact spacing requirements between the drum surface and the magnetic head have required almost solid metal to achieve close tolerances, and this has led to very heavy and expensive drums.

A new principle allows the heads to be movable, actually resting on the drum itself, but positioned and lubricated by a film of air—"air floating" of heads. The heads are movable in their mountings: and a small supply of high-pressure air is allowed to flow out through tiny openings in the mounting near the recording surface. Using this principle, very large drums of light welded, sheet metal with a magnetic surface can be used, and information can be legibly recorded even more densely than on conventional small, solid drums. (*From new 4-page "Air Floating" brochure, Logistics Research, Inc., Redondo Beach, Calif.*)

For this literature circle **402** on inquiry card.

Process Control Simulation

An example of a process control simulation is that of temperature control of a Xylene tower. The problem is to determine controller settings for optimum recovery of the temperature at the bottom of a Xylene column following a step disturbance. Fig. 3 represent the block diagram of this negative feedback system. Although the computer may be run on a real time basis, it is more convenient for this

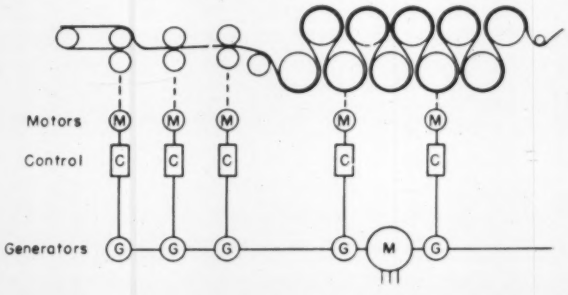


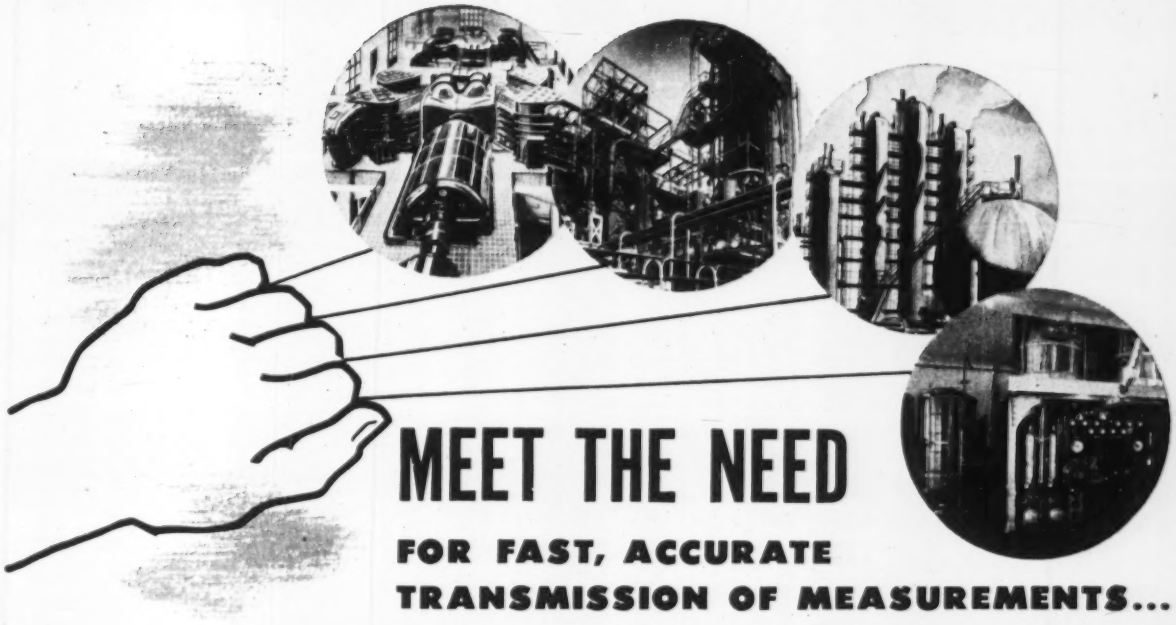
problem to be scaled up by a factor of 5, so that the computer will operate five times as fast as the field system and the operator will not wait as long for each solution. The computer will be made to record this error upon the input of a step load disturbance; then the proportional gain, reset rate, and rate time potentiometers may be varied in a logical manner until the recovery time and error is at a minimum. When optimum condition is attained, it is necessary to reconvert the proportional, reset, and rate gains in the computer to the real values in the system. Results: proportional gain equals 1.7 to 2.0; reset rate equals 6 to 8 repeats per min.; rate time equals 0.11 to 0.14 min. (*From new 8-page brochure, "Computer Techniques in the Instrumentation Industries," Berkeley Div., Beckman Instruments, 2200 Wright Ave., Richmond, Calif.*)

For this literature circle **403** on inquiry card.

Machine Drives

In the G-E Multiple-Generator Sectional Drive, each motor is powered by its own d-c generator. While each is individually controlled for maximum flexibility, relative speeds between sections are carefully co-ordinated. Special tachometer-generators on each section motor supply the speed signal, and electronic amplidyne regulators maintain





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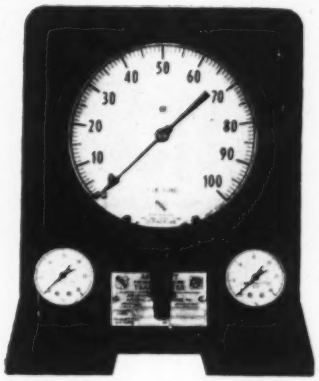

ASHCROFT PNEUMATIC PRESSURE TRANSMITTER with two 2-inch gauges, one reading "Air Supply," the other "Transmitted Air." Other types available for temperature, differential pressure, flow and liquid level.

Measurements of pressure, temperature, differential pressure, flow and liquid level must be transmitted quickly, accurately and safely to assure the efficiency required by modern process engineering. Ashcroft Pneumatic Transmitters more than fill those requirements—contribute greatly to the perfect performance demanded of vital instrumentation at one or more remote control centers.

Ashcroft Transmitters are ideal for all process industries and power stations—wherever it is desirable to confine high pressures or inflammable, poisonous or corrosive liquids and gases close to their source. They are also highly suitable where fire or explosion hazards make electrical wiring objectionable, or where the existing source of compressed air can easily be used.

Built into Ashcroft Transmitters are many design advantages proved through years of experience in manufacturing pressure gauges. They operate on low-pressure air—transmit proportionate air pressures to one or more pressure-actuated receiving indicators, recorders and controllers up to 1000 feet away with accuracy within ½ of 1%. Expensive, high-pressure lines and fittings, with all their leakage and maintenance problems, are avoided.

Write for details about Ashcroft Pneumatic Transmitters. Or ask your nearby Instrument Distributor for complete data on all types.

YOUR INSTRUMENT DISTRIBUTOR carries Manning, Maxwell & Moore products because he wants to be sure you get the best in quality, performance and economy. You can depend on him for prompt service.

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It's Fast...in operation and quickly read. Precision movement designed to laboratory standards. Direct reading scale face is easily understood—no slide wires or conversion tables necessary.

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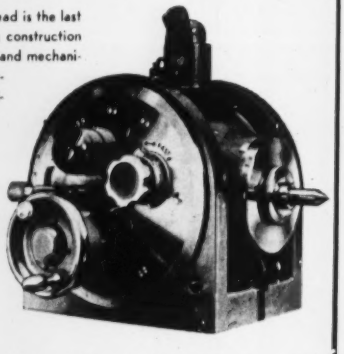
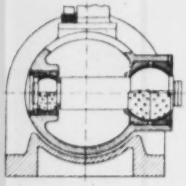
The LEITZ Optical Dividing Head is the last word in indexing precision. Its construction is different from other optical and mechanical dividing heads on the market. A NEW DOUBLE SPHERICAL BALL BEARING, DOUBLE READING IN THE SAME EYEPIECE 180° APART, motor drive attachment and other features make the LEITZ an important aid required in any shop where precision is demanded.





The 2 spherical ends of the spindle are carried in hardened steel cups with several hundred small precision balls held in place by ball cages in such a way that each ball creates its own path. There is no play, either radially or axially, no oil film, no wear and a very large load capacity.

Write for Descriptive Bulletin

Geo. SCHERR OPTICAL TOOLS, Inc.

200-MG LAFAYETTE STREET • NEW YORK 12, N. Y.

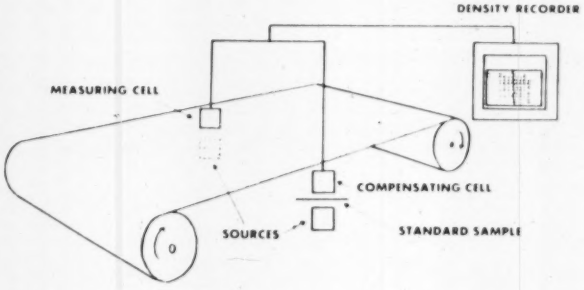
For more information circle **114** on inquiry card.

the set speed with utmost precision. (*From new 8-page Catalog GEA-5712A, General Electric, Schenectady 5, N. Y.*

For this literature circle **404** on inquiry card.

Nucleonic Density Measurement

Shown is system for continuous comparison of the density of a moving web to the density of standard sample. The accuracy and sensitivity of measurements of this type is



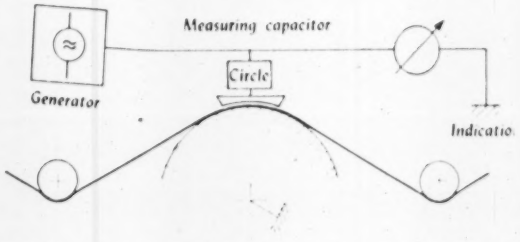
primarily dependent upon the size and type of the radioactive source used. In certain cases, instrument scales may be expanded 100 times if required. Similar comparisons may be made between liquid or gaseous samples and comparable unknown flowing materials. (*From new 4-page Bulletin 104, Ohmart Corp., 2236 Bogen St., Cincinnati, Ohio.*)

For this literature circle **405** on inquiry card.

Basis-weight and Thickness

Various principles can be used to measure the basis weight and caliper of fibrous materials—(1) capacitive

Principle of the dielectric measuring of caliper



dielectric measurement, (2) absorption of radioactive matter in sheet, (3) mechanical-electrical measurement. (*From new 6-page (Feb. 1954) issue of "Important Message," Hygrotester, Inc., P. O. Box 923, Brooklyn 1, N. Y.*)

For this literature circle **406** on inquiry card.

Anti-friction Material

"Graphalloy" consists of graphite or carbon-graphite in solid molded form, the pores of which are impregnated with molten metal . . . contains no oil and requires no oil. It depends for its self-lubrication properties on the combined metallic and graphitic nature of its structure.

Babbitt Graphalloy, Copper Graphalloy, Bronze Graphalloy, Cadmium Graphalloy, and Silver Graphalloy are the common types. Other metals, alloys and non-metallic impregnants are used in special applications. (*From new 8-page bulletin, The Kotula Co., 400 Madison Ave., N. Y., N. Y.*)

For this literature circle **407** on inquiry card.

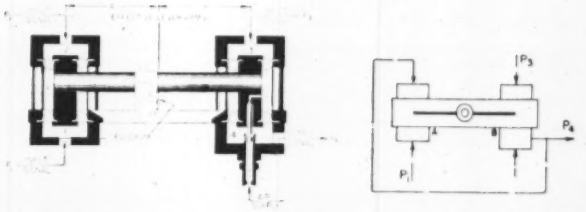
Teflon

DuPont "Teflon" is the remarkable plastic that is unaffected by almost all chemicals—has outstanding dielectric and non-adhesive properties and can be used in temperatures from —320 to 500 deg. fahrenheit . . . A superior thread-sealing compound was recently developed by the Flexrok Company . . . designated "Frexrock 25, Teflon Pipe Dope" . . . recommended for chrome, chrome plate, nickel steel, ceramic and plastic pipe threads, and for joining or connecting dissimilar materials . . . "Flexrock 80" is a pressure-sensitive adhesive developed for bonding Teflon to itself and other materials . . . metals, glass, paper, plastics. *(From new 14-page brochure and 4-page Form PR, Flexrock Co., Philadelphia 1, Pa.)*

For this literature circle **408** on inquiry card.

Pneumatic Computer

In all except the very simplest control systems, there is need for control mechanisms which can combine control signals. Some of these combinations involve addition or subtraction of control signals, while others involve multiplication, division, or even more complicated functions. The Hagan Ratio Totalizer is designed for almost universal



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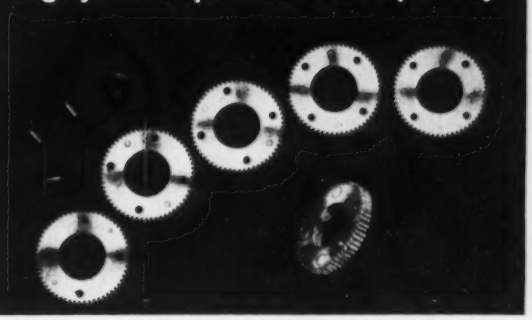

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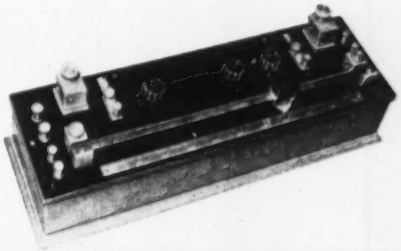

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The Gray Model E-1653 Kelvin Bridge illustrated will do this readily.

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Make just three connections and you are ready to boost 100 psi. plant supplied air pressure to 10,000 psi. fluid pressure for $278.25 (FOB Gardena, Calif.). Eight standard models for output fluid pressures of 1,000 to 30,000 psi. Special models for lower or higher pressures.

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For more information circle **119** on inquiry card.

BRIEFS—CONTINUED

application in this type of service. It represents an advance in simplicity and versatility.

Basically a four-chamber force-balance mechanism, the output signal (P4) automatically adjusts itself so that

(P4–P3) (lever-arm B) = (P1–P2) (level-arm A)

By adjusting lever arms, and by connecting to various chambers, the output signal can be made the sum of two signals, the difference between two signals, any ratio of an input signal, or the average of two signals. By use of a needle valve and volume tank, the output can be made proportional to the rate of change of a signal. (*From* 8-*page Bulletin* 5452, *Hagan Corp., Hagan Bldg., Pittsburgh* 30, *Pa.*)

For this literature circle **409** on inquiry card.

Mercury Switches

Mercury switches are essentially single-pole devices. However, different contact arrangements are available: (*From*

new 12-*page Catalog* 90, *Microswitch Div., Minneapolis-Honeywell, Freeport, Ill.*)

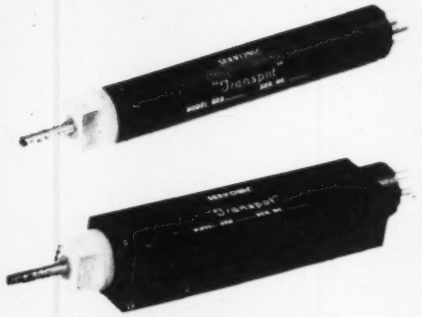
For this literature circle **410** on inquiry card.

Electrostatic Storage

Fast as it is, magnetic recording is still not fast enough for everything the engineers have in mind. Consequently, IBM has done a great deal of work on what is called "elec-

SERVONIC

Model G TRANSLATION POT



The "TRANSPOT"

is a linear translation potentiometer designed for versatility and compactness. Available in single or dual wire-wound types.

Various strokes and resolutions available.

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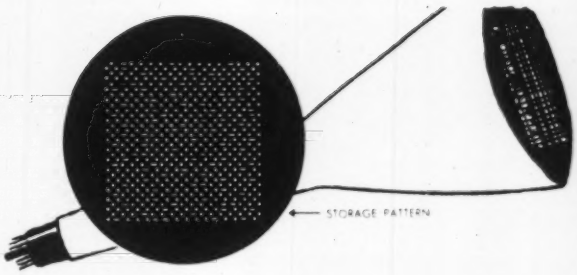

trostatic storage"; that is, the recording of information in the form of electrical charges on the face of a cathode-ray tube. This is the same basic type of tube as the picture tube in a television set. It is considerably smaller and the "picture" it stores is a pattern of dots and dashes. These dots and dashes represent characters in the same way as the fields in magnetic recording.

There are two big advantages of electrostatic storage. It is one of the fastest of any type known, doing its job in a few millionths of a second, and it is capable of what is called "instantaneous random access." This means that the electronic beam which reads and writes on the face of the tube can go directly to any given "address" without having to scan the entire tube in a fixed sequence. Other types of storage, such as drums, have to wait until the desired piece of information passes by the reading-writing device. (*From new 32-page Booklet Form 52, "Light on the Future," IBM, 590 Madison Ave., N. Y., N. Y.*)

For this literature circle **411** on inquiry card.

Pressure Regulation

"Type 28" pressure-balanced diaphragm motor valves are inexpensive regulators that provide highly sensitive control

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DWYER
MAGNEHELIC GAGE
has the
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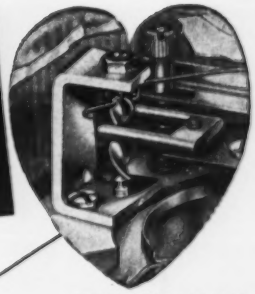
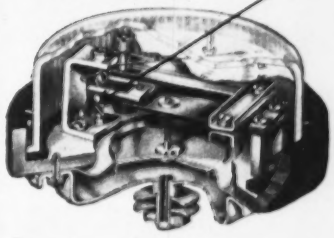
Not subject to surge or vibration damage





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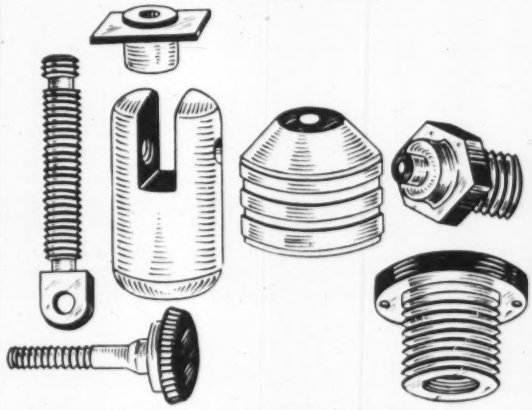

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TRADE MARK REGISTERED
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Combine high and low temperatures within the same cabinet with all controls self contained. Unit measures 50"x28"x20" with a testing chamber 12"x12"x12". Temperature range is from -80° F. to 185° F. Heat application is accomplished with reverse cycle refrigeration, which eliminates the hazards associated with open heating elements. A blower is provided for even distribution of temperatures and greater testing accuracy. Latch-type or hinge-type door optional. Accelerated pull-down to -80° in 90 minutes or less.

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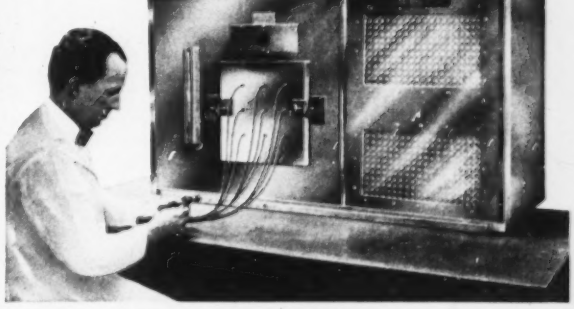

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Proximity Actuated Transducer

produces constant electrical output independent of speed or motion

MODEL 4900

No mechanical contact with exciting metal

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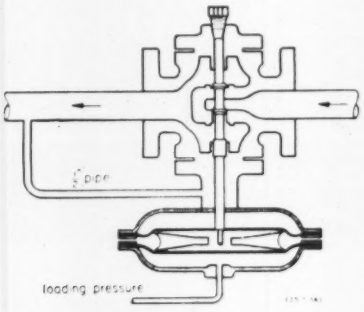
BRIEFS—CONTINUED

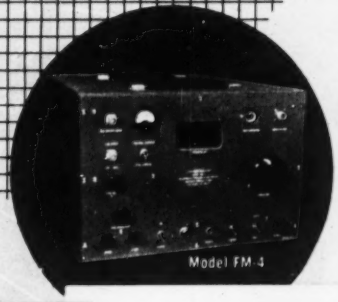


of outlet pressure. Either liquids or gases are dependably handled with very rapid response to widely varying flows and upstream pressures. Basically, "Type 28" is a springless double-seated valve with a downstream take-off connected back to the lower pressure chamber of the top works. (*From new 2-page Spec. Sheet* 425, *Minneapolis-Honeywell, Ind. Div., Phila.* 44, *Pa.*)

For this literature circle **412** on inquiry card.

Microflash-Inkometer Study

Attempts to correlate theoretical studies of physical properties of printing ink with actual press results observed are often unsuccessful for short, stiff inks and inks used for high-speed press operation. Mr. Lars H. Sjodahl of the International Printing Ink Division of Interchemical Corporation has studied this problem using an inkometer and the Microflash. The inkometer allows measurement of the torque required to split an ink film of predetermined thick-



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Continuous Coverage
Extremely High Accuracy and Stability

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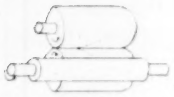

ness. It consists essentially of two inked rollers, the speed of which can be varied to simulate actual press condition. The Microflash allows high-speed photographs to be taken of the ink filaments that form as the ink film on the rollers separates. (*From "Experimenter," Vol. 28, No. 7, General Radio Co., Cambridge 39, Mass.*)

For this literature circle **413** on inquiry card.

Packaged Plug-in Circuits

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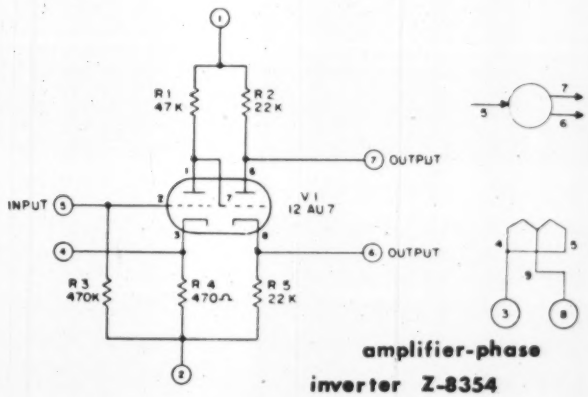
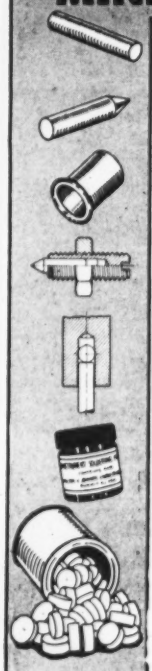


amplifier-phase inverter Z-8354

MINIATURE PARTS



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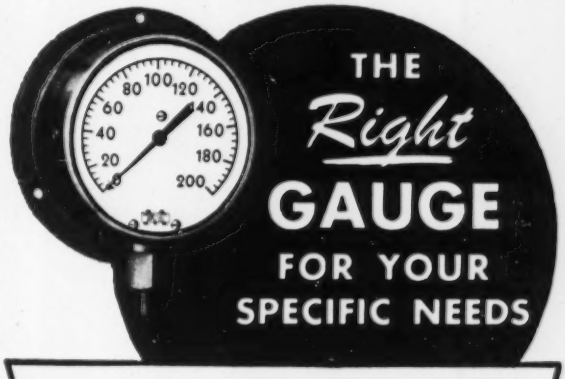

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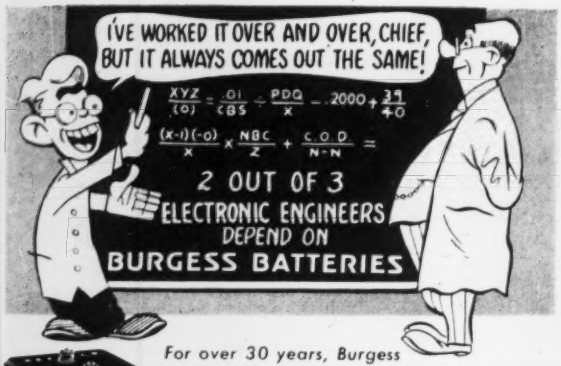
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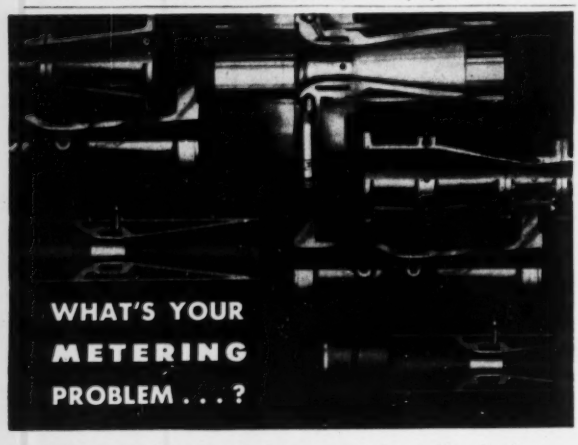

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For more information circle **131** on inquiry card.

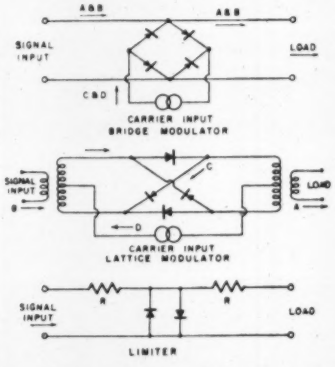
BRIEFS—CONTINUED

lines, etc. (*From new 12-page Catalog C-3, Electronic Engineering Co., 180 S. Alvarado St., Los Angeles, Calif.*)

For this literature circle **414** on inquiry card.

Selenium Rectifiers

There are numerous possible applications for selenium rectifiers, three of which are modulation bridges, lattice modulators and limiters in carrier equipment. Typical circuits for these particular applications are given in Fig. 6.



The current rating for operation at an ambient of 35 C. is usually limited to 60 ma. in half-wave circuits. However, units of higher current rating may be obtained as "specials" from the manufacturer. (*From 4-page "Survey of Various Types of Selenium Rectifiers," International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*)

For this literature circle **415** on inquiry card.

AGASTAT

Compact . . . Dust-Proof
TIME DELAY RELAYS
solenoid actuated—pneumatically timed

Introduces time delays into a-c or d-c circuits. Easily adjusted to provide delays ranging from 0.1 second to five or more minutes.

The AGASTAT is small, light, and operates in any position. Dust-proof timing chamber assures long operating life with a minimum of maintenance.

Write for Bulletin. Dept. A1-59,

AGA

Division of Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth 3, New Jersey

For more information circle **132** on inquiry card.

System Evaluation

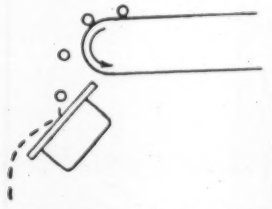
Before systems such as end point control can be realized, it is necessary to know *exactly* how the process will react under any condition of load or disturbance. How can a computer calculate the necessary data to insure product quality, if the control of variables being fed into the computer is not stabilized?

The application of feedback control theory will permit a complete analysis of these complex systems *before* they are designed and installed; and System Engineering will be the technique of designing such systems.

There is still another use for these techniques in the development of such systems. Through the use of analogs, it is possible to investigate several solutions to a particular problem *without* the capital investment that would be required in the case of models, pilot plants, and field tests. (*From "Instrumentation," Vol. 7 No. 1, Minneapolis-Honeywell, Ind. Div., Phila. 44, Pa.*)

For this literature circle **416** on inquiry card.

Impact, Surge Switches



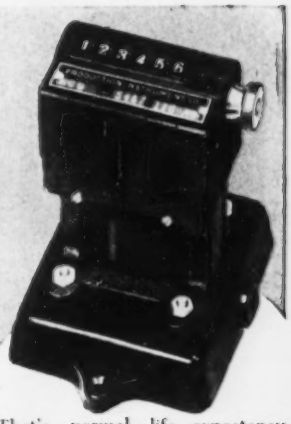
"Impak-Switch" uses an electronically operated relay that is triggered by falling parts. Used for counting, protection, stoppage signals, etc.

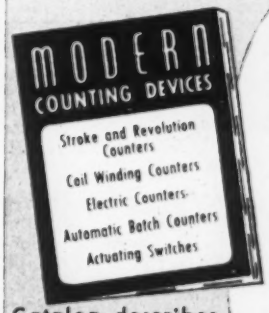
"Surj-Switch" operates when any work-produced current surge occurs in line. Any electrically-operated equipment produces surges when work is being done. Hence uses include lubrication control, counter actuation, safety, stoppage control. (*From new 2-page Bulletins 10 and 11, Autotron Co., P. O. Box 722, Danville, Ill.*)

For this literature circle **417** on inquiry card.

300 MILLION count life

Forty years at 18000 counts per hour 40 hours per week





Catalog describes counters, LARGE and small, pre-determined, mechanical, electric, photo-electric, coil winding. Send for your copy.

That's normal life expectancy for PIC world famous Wizard Electric Counters on AC with built-in rectification, and on DC.

Power consumption under 5 watts permits actuation (without relay) in plate circuit of many electronic tubes.

Balanced armature avoids miscounts that result from vibration with other types of counters.

Furnished for most any voltage up to 220, AC or DC, in standard, panelmount, or dustproof enclosed models, with four or six number wheels.

See your PIC Representative or write.

PRODUCTION INSTRUMENT COMPANY
702 W. Jackson Blvd., Chicago 6, Ill.

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NEW MARSH
Serviceman Soundscope

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Most effective instrument ever developed for pin-pointing and identifying mechanical defects. Saves time and dollars tracking down troubles in bearings, gears, mechanisms . . . detects leaks, knocks, piston slaps—any defects that make a sound. A precision instrument of Marsh quality, sensitive to faintest sounds . . . with handy probe and headband as illustrated. A remarkable tool, moderately priced.

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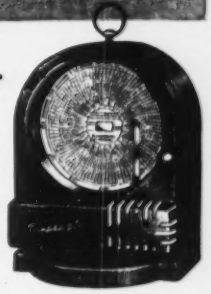
TEMPSCRIBE Recording Thermometer



Available in 10 different ranges to cover −30°F to +160°F temperatures, and with spring-operated chart drives for any of the following chart rotations: 8 hours, 24 hours or 7 days.

This entirely self-contained, compact and reliable temperature recorder automatically writes a continuous record of temperature changes on a replaceable chart. Record shows at a glance maximum and minumum temperatures and the duration of temperatures above or below any given point; also shows the exact time of every temperature change and how rapidly it takes place. Recording pen and bi-metallic element are built in hinged, removable door which is also front of instrument. Thus, by merely changing doors it is easy to interchange temperature ranges. Instrument is 8" tall, 5½" wide and 4½" deep. Charts are 4½ inches in diameter.

Write for Bulletin I-715

FLORITE Anemometer

In principle, this unique instrument operates as an anemometer but provides instantaneous, direct readings of air velocity without timing, calculations or reference to charts. Readings are obtained by holding the instrument in the air stream so that air blows against its circular face, causing rotation of a multi-blade rotor mounted in instrument housing. The circular scale surrounding the rotor instantly turns to correct air velocity reading under an index pointer on scale window. Furnished with detachable handle (not shown) and leather case.

Available in two styles: One with a scale of 0-1000 ft./min., and the other with a double scale of 0-3000 ft./min. and 0-35 miles per hour.

Write for Bulletin I-760

BACHARACH Industrial Instrument Co.
7301 PENN AVENUE • • PITTSBURGH 8, PA.

For more information circle **135** on inquiry card.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 821.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Recording Controller. New 20-page Bulletin GED-2100 describes and illustrates maker's new recording controller, featuring potentiometer with continuous standardization through magnetic standard, and pneumatic controller with proportional, rate and reset response.—General Electric, Schenectady, N. Y.

Circle **418** on inquiry card.

Process Control. New 4-page issue (Vol. 14 No. 3) of "Wheelco Comments" features articles on control of thermoplastic forming machines by maker's "Capacilogs" and "Limitrols."—Barber-Colman Co., Rockford, Ill.

Circle **419** on inquiry card.

Pump Control Systems. New illustrated 4-page Catalog 91-106 presents description and operation principles of maker's line of automatic pump-sequence-control systems based on principles of kinetic manometry.—Fischer & Porter Co., Hatboro, Pa.

Circle **420** on inquiry card.

Cement Industry Modernization. New 16-page Bulletin GEA-5984 on "Electrical Modernization of the Cement Industry" provides step-by-step information on how to modernize electrically without shutdowns.—General Electric, Schenectady, N. Y.

Circle **421** on inquiry card.

Servo Design. New 2-page Bulletin TDS 1110 describes and illustrates maker's "Servoboard Model 1110A" experimental mechanical component group developed as an aid to design of servomechanisms.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.

Circle **422** on inquiry card.

Remote Controller. New 2-page brochure presents maker's new "Model PV-5010" remote controller for Grove regulator.—Avionic Products Engineering Corp., Route 46, Dover, N. J.

Circle **423** on inquiry card.

CONTROL VALVES

Electric Control Valves. New 16-page Catalog 8203 covers complete line of maker's electric-motor control valves. Includes control motors, control modes, and valve-body types. —Industrial Div., Minneapolis-Honeywell Reg. Co., Phila. 44, Pa.

Circle **424** on inquiry card.

Ammonia Valves. New 2-page illustrated Bulletin 2010 describes line of ammonia valves and accessories for refrigeration and air conditioning equipment.—Henry Valve Co., 3215 North Ave., Melrose Park, Ill.

Circle **425** on inquiry card.

Solenoid Valve. New 2-page Bulletin 530 illustrates and describes maker's quick-exhaust "V5-3" solenoid valve.—Skinner Chuck Co., New Britain, Conn.

Circle **426** on inquiry card.

Solenoid Valves. New 6-page Bulletin 55 describes maker's new line of solenoid-controlled, pilot-operated, 4-way valves for 100 to 5000 psi.—Pantex Mfg. Corp., Pawtucket, R. I.

Circle **427** on inquiry card.

Flow Control Valves. New 4-page bulletin pictures and describes solenoid valves for liquids, gas and air, and refrigerants. Also check valves, expansion, special, and other types.—A-P Controls Corp., 2497 N. 32 St., Milwaukee, Wis.

Circle **428** on inquiry card.

MOTORS, SERVOS

Synchros. New 24-page illustrated booklet "The Synchro Story" describes what synchros are and covers manufacture.—Clifton Precision Products Co., Inc., Clifton Heights, Pa.

Circle **429** on inquiry card.

Synchros, Servos, Resolvers. New 4-page brochure describes maker's full line of synchros, servo motors and sine-cosine resolvers.—Ketay Mfg. Corp., 55 Broadway, New York, N. Y.

Circle **430** on inquiry card.

Servos, Computers. New 12-page illustrated bulletin "Computers, Components, Control Systems" describes electronic, electrical, and electromechanical components of plug-in design for aircraft and industrial use.—Servomechanisms, Inc., Post & Stewart Ave., Westbury, N. Y.

Circle **431** on inquiry card.

Autosyns, Synchros, Motors. New 38-page illustrated Catalog 39 (Surplus Division) describes and illustrates surplus fractional-hp. motors, selsyns, servos, etc.—Servo-Tek Products Co., Inc., Hawthorne, N. J.

Circle **432** on inquiry card.

Servo Motors. New 4-page Catalog 4 covers small a-c. servo motors and tachometer generators for use on 60 and 400 cycles at voltages from 26 to 115.—G-M Laboratories Inc., 4300 North Knox Ave., Chicago, Ill.

Circle **433** on inquiry card.

Sub-fractional-hp. Motors. New 8-page illustrated bulletin describes induction, synchronous, and servo motors for gearhead, blower, fan, and torque motor applications.—Induction Motors Corp., 570 Main St., Westbury, L. I., N. Y.

Circle **434** on inquiry card.

Instrument Motors. New 4-page Catalog BED-A18 presents maker's new line of synchronous and induction motors.—Borg Equipment Div., George W. Borg Corp., 120 S. Main St., Janesville, Wis.

Circle **435** on inquiry card.

Governor Motors. New 4-page issue of "The Bodine Motorgram" (Vol. 34 No. 2) features articles on balancing rotating parts and on characteristics of governor-type motors.—Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

Circle **436** on inquiry card.

Fractional-hp. Motors. New 12-page catalog presents maker's line of subfractional-hp. motors, including universal, direct-current, and shaded-pole motors.—Howard Industries, Racine, Wis.

Circle **437** on inquiry card.

Reed Synchronous Motors. New 4-page illustrated bulletin presents specifications and performance curves of typical motors in maker's line of reed-controlled d-c. motors and timers.—Amglo Corp., 2037 W. Division St., Chicago, Ill.

Circle **438** on inquiry card.

RECORDING

Dual Recording Milliammeter. New 4-page Bulletin DL-C 400 presents features, design, description and operation principles of maker's new ink-writing, dual recording milliammeter, featuring magnetic fluid clutch drives. —Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex.

Circle **439** on inquiry card.

Recording Oscillographs. New 12-page issue of "Hathaway Engineering News" (Vol. 4 No. 1) features articles on "Model S14" oscillograph and on bifilar oscillograph galvanometers.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.

Circle **440** on inquiry card.

Writing Galvanometers. New 2-page Bulletin B-1 presents maker's line of ink-writing galvanometers for research and industrial instrumentation.—Edin Co., 207 Main St., Worcester, Mass.

Circle **441** on inquiry card.

Oscillograph. New 2-page Temporary Information Sheet presents new "Model 70" subminiature oscillograph, featuring galvanometer types with natural frequencies from 40 to 5000 cycles permitting recording from 0 to 300 cps.—Heiland Research Corp., 130 E. 5th Ave., Denver, Colo.

Circle **442** on inquiry card.

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Designed to hold small drills in precision collets, thus overcoming the difficulty of making a drill run true as when held in a conventional drill chuck. Absence of a sliding quill guarantees maximum sensitivity with fingertip control. A mounted ⅛" capacity chuck can also be used.

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For more information circle 136 on inquiry card.

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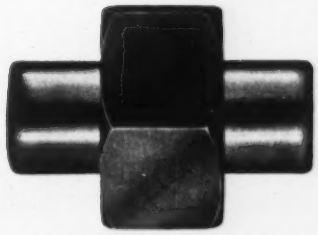
I.I.C. SUR-WAY UNIONS



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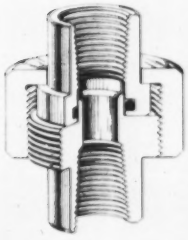

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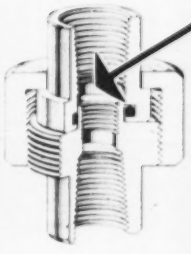

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WITH SCREW-IN ORIFICES

I.I.C. Sur-Way Orifice Unions are furnished with stainless steel orifices bored to specified size. This new type orifice is easy to insert or remove.

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For more information circle 138 on inquiry card.

MANUFACTURERS' NEW LITERATURE

Multi-channel Amplifier. New 2-page illustrated Bulletin 300 presents circuit and specifications of maker's "DC-1B" multi-channel amplifier system for oscillograph and tape recording.—Wm. Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena, Calif.

Circle **443** on inquiry card.

X, Y Recorder, Curve Follower. New 4-page Bulletin 5M describes maker's "Autograf" function plotter; 2-page brochure presents companion curve follower.—F. L. Moseley Co. 409 N. Fair Oaks Ave., Pasadena, Calif.

Circle **444** on inquiry card.

Magnetic-tape Handler. New 2-page Bulletin A-901 presents maker's "Model 902" digital magnetic-tape handler for intermittent or continuous recording and playback of digital information.—Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, N. Y.

Circle **445** on inquiry card.

Multichannel Oscillographs. New 2-page bulletin illustrates and describes maker's new multichannel oscillographs with remote electrically-controlled chart-drive system.—Brush Electronics Co., 3405 Perkins Ave., Cleveland, Ohio.

Circle **446** on inquiry card.

Recording Oscillograph. New 4-page Bulletin CEC-1536 announces maker's new "5-119" 50-channel recording oscillograph.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **447** on inquiry card.

Tape Recorder. New 4-page issue of "Allied News" (Vol. 10 No. 1) features descriptions of tape recorder, time switch, and transistor batteries.—Allied Radio Corp., 100 N. Western Ave., Chicago, Ill.

Circle **448** on inquiry card.

Drum Recorder. New 8-page Bulletin D3-1-7 presents description, illustrations and diagrams of maker's new magnetic tape seismic drum recorder "Model 700" for tape recording of seismic signals.—Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle **449** on inquiry card.

TEMPERATURE

Thermocouples, Glands. New 16-page Catalog 1530 illustrates and describes maker's full line of thermocouples, bare-wire thermocouple glands, protection tubes, change-under-pressure glands, and packing glands.—Conax Corp., 4515 Main St., Buffalo, N. Y.

Circle **450** on inquiry card.

Temperature Recorders. New 8-page Bulletin 60 presents maker's potentiometer-pyrometer and resistance-thermometer industrial temperature indicators.—Thermo Electric Co., Inc., Saddle River Twp., Rochelle Park P. O., N. J.

Circle **451** on inquiry card.

Temperature Indicators. New 8-page bulletin A-303 pictures and describes two portable temperature indicators—a Potentiometer-indicator, and a Resistance-thermometer.—The Foxboro Co., Foxboro, Mass.

Circle **452** on inquiry card.

Temperature Computer. New Data Sheet No. 5 gives specifications of maker's new "Model C-1029" automatic arithmetic average-temperature computer for use with up to 30 thermocouples. Aero Research Instrument Co. Inc., 1901 N. Hermitage Ave., Chicago, Ill.

Circle **453** on inquiry card.

Low-temperature Cabinets. New 2-page bulletin presents maker's "101" low-temperature units that remove 100 BTU's per-hour at minus 120 F.—Mede Corp., 1741 2nd St., Highland Park, Ill.

Circle **454** on inquiry card.

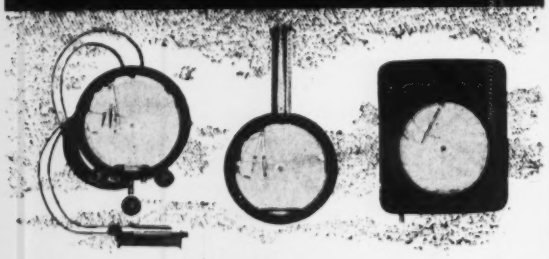
Thermocouple Circuit Restorer. New 4-page reprint is article on thermocouple-circuit "Restorer."—Sherman Electric Co., 1807 Elm Rd., N. E., Warren, Ohio.

Circle **455** on inquiry card.

Pyrometry. New 6-page Bulletin 4371 contains summary of advantages of thermoelectric pyrometers and pre-

WIDEST RANGE OF EQUIPMENT FOR

HUMIDITY RECORDING



No matter what problems you face in obtaining suitable humidity measurements and records, the unique versatility of Foxboro Humidity Instrumentation offers an appropriate solution. Included are Recorders, Recorder-Controllers, Indicators, for relative humidity (hair and membrane), wet-and-dry bulb measurements, and for direct reading dewpoint or absolute humidity measurement (with the exclusive Dewcel element). Available in portable, close-coupled and long-distance types; with round or rectangular cases.

Write for full details in Bulletins 188-5 and 407. The Foxboro Company, 465 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO HUMIDITY INSTRUMENTS

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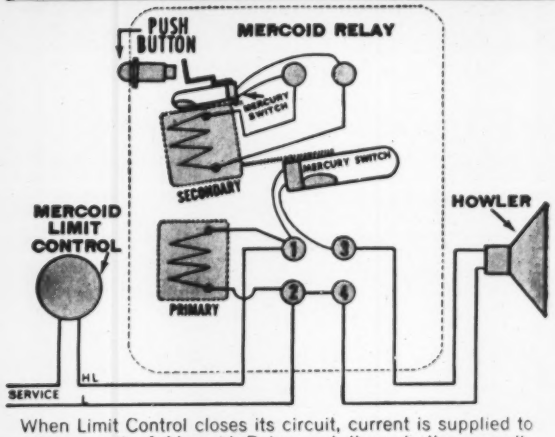
MERCOID RELAY FOR AUDIBLE ALARM



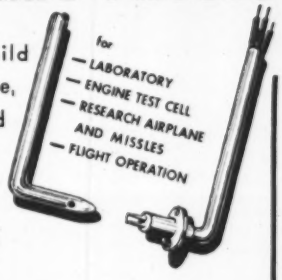
When Limit Control closes its circuit, current is supplied to primary coil of Mercoid Relay and through the normally closed mercury switch to the "Howler" (alarm). To stop "Howler," operator pushes in "push button" which manually raises relay secondary and breaks circuit to "Howler." Secondary is held up by magnetic repulsion until condition is corrected. When limit control opens the primary circuit of relay, secondary coil drops to normal position and relay is automatically ready for another operation.

WRITE FOR BULLETIN CA-8R

THE MERCOID CORPORATION, 4201 BELMONT AVE., CHICAGO, ILL.

For more information circle **140** on inquiry card.

AERODYNAMIC PROBES



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The Precision Potentiometer as a Voltage Divider

By H. A. Schmidt
Sales Engineer,
Helipot Corporation

Write for Data File 511

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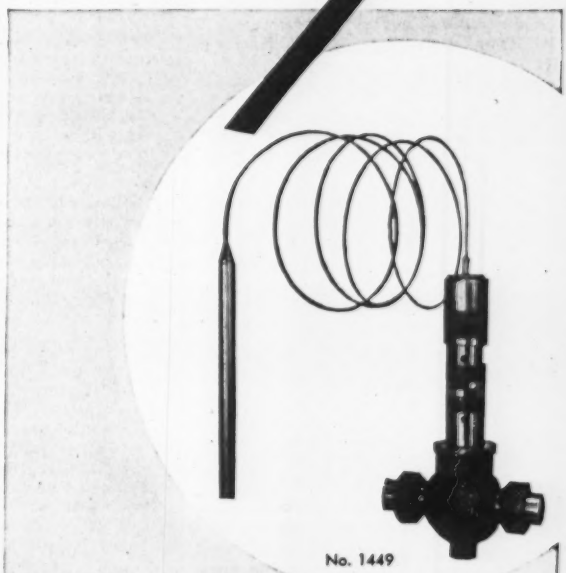

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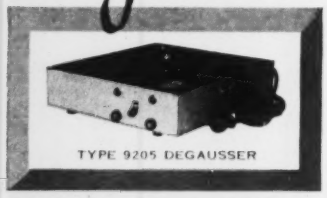

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MANUFACTURERS' NEW LITERATURE

sents maker's "Series A, Series R, and Series E" pyrometers.—Illinois Testing Laboratories, 420 North La Salle St., Chicago, Ill.

Circle **456** on inquiry card.

Thermistors, Conductivity Cells, Varistors. New 10-page brochure presents code numbers, descriptions and resistances of maker's line of thermistor assemblies, thermal conductivity cells, gas analyzers, and varistors. —Victory Engineering Corp., Springfield Rd., Union, N. J.

Circle **457** on inquiry card.

Bimetal Thermostats. New 2-page bulletin presents construction and applications of maker's new "Type W" bimetal-strip thermostats for electronic and industrial devices.—Stevens Mfg. Co., Inc., Mansfield, Ohio.

Circle **458** on inquiry card.

Platinum-resistant Thermometers. New 2-page Bulletin 2247 presents description, specifications and diagrams of maker's stain-free platinum-resistance thermometer with a range from minus 183 to plus 500 C. —American Instrument Co., Inc., Silver Springs, Md.

Circle **459** on inquiry card.

Temperature Alarm. New 2-page bulletin describes "T-173-A" Pulsitometer for use in aircraft fire detection or overheat circuit.—Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, Calif.

Circle **460** on inquiry card.

Heat Exchangers, Glassed Steel Reactors. New 4-page brochure illustrates and describes maker's glassed steel reactors, glassed steel columns and alloy heat exchangers.—The Pfaudler Co., 100 West Ave., Rochester, N. Y.

Circle **461** on inquiry card.

Temperature Regulators. New 4-page illustrated bulletin describes design and operation features of maker's self-operated temperature regulators.—Spence Engineering Co., Walden, N. Y.

Circle **462** on inquiry card.

Dial Thermometers. New 4-page bulletin presents specifications and diagrams of maker's dial thermometers for industrial and laboratory applications.—Marshall Instruments Inc., 7333 Coldwater Canyon Ave., N. Hollywood, Calif.

Circle **463** on inquiry card.

PRESSURE

Pressure, Temperature, Flow. New 68-page Catalog 64 describes and illustrates maker's full line of pressure, temperature, flow and level gages, and electrical measuring instruments. Includes more than 97 indexed models for specific applications.—United States Gauge, Sellersville, Pa.

Circle **464** on inquiry card.

High-vacuum Pumps. New 8-page Data Sheet 6-55 contains operating data and performance curves for the

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maker's line of high-vacuum oil-diffusion pumps with ultimate pressures of 5×10^{-7} mm. Hg. at 25 deg. C.—Consolidated Vacuum Corp., Rochester, N. Y.

Circle **465** on inquiry card.

Pressure, Vacuum Gages. New 124-page Catalog 300 describes and illustrates maker's large line of gages, including indicating and recording gages, gage testers, mercurial barometers, mercury columns, etc.—Manning, Maxwell & Moore Inc., Stratford, Conn.

Circle **466** on inquiry card.

Pressure Transmitter. New 4-page Catalog 4000 describes and illustrates maker's "Model 6100F" pneumatic pressure transmitter for remote measurement of pressure or level, or where a seal is needed between system and gage.—King Engineering Corp., Ann Arbor, Mich.

Circle **467** on inquiry card.

Pneumatic Transmitter. New 2-page Bulletin 1025 presents maker's pressure- gage and pneumatic-transmitter unit for measurement and conversion of 0-100,000 psig. (input) to 3-15 psig. (output). Includes capacities, pressures, and operating details.—Penn Industrial Instrument Corp., 4110 Haverford Ave., Phila., Pa.

Circle **468** on inquiry card.

Pressure Pickups. New 2-page Bulletin 4530 illustrates and describes maker's new potentiometer-pickup pressure detectors. Includes miniature units with ranges to 3000 psid.—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

Circle **469** on inquiry card.

Mechanical Manometers. New 2-page bulletin illustrates and describes maker's line of mechanical manometers (available both as direct reading indicators, with dial pointer, and as transducers with electrical outputs) for low pressure-differentials.—Colvin Laboratories, Inc., East Orange, N. J.

Circle **470** on inquiry card.

Rupture Disc. New 6-page Catalog 77-30 describes maker's new type of rupture disc for low pressure and highly corrosive applications.—Black, Sivalls & Bryson, Inc., 7500 E. 12 St., Kansas City, Mo.

Circle **471** on inquiry card.

Pressure, Acceleration. New 8-page catalog describes and illustrates maker's line of devices for measurement and control. Includes accelerometers, differential transformers, pressure transducers.—Schaevitz Engineering, P. O. Box 505, Camden, N. J.

Circle **472** on inquiry card.

Pressure Pickups. New 4-page brochure gives specifications, model numbers and price list maker's line of pressure pickups featuring new "Dynawheel" design.—Dynamic Instrument Co., 28 Carleton St., Cambridge, Mass.

Circle **473** on inquiry card.

FLOW

Flow Metering. New 36-page catalog describes and illustrates maker's

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NEW LITERATURE

orifice fittings, orifice plate holders, meter runs, straightening vanes, check valves, condensate chambers and seal chambers, mercury traps, and other products for measurement and control of liquids and gases.—Daniel Orifice Fitting Co., 3352 Union Pacific Ave., Los Angeles, Calif.

Circle **474** on inquiry card.

Miniature Venturi Tube. New 5-page brochure describes maker's "Type TF" Venturi tube for measurement of liquids in quanities too low for application of normal-size Venturi.—Simplex Valve & Meter Co., 68th & Upland St., Phila., Pa.

Circle **475** on inquiry card.

Flow Limit Alarm. New 2-page Bulletin presents maker's "Model 103" electric Flo-Gard for high or low flow alarms.—Brooks Rotameter Co., Lansdale, Pa.

Circle **476** on inquiry card.

Sight Flow Indicators. New 2-page bulletin presents description, specifications and illustrations of maker's "S-300" and "F-960 sight flow indicators for transparent solutions and gases.—Jacoby-Tarbox Corp., 808 Nepperhan Ave., Yonkers, N. Y.

Circle **477** on inquiry card.

PUMPS

Controlled-volume Pumping. New 4-page illustrated Technical Paper 59 explains controlled volume pumping of minute flows; 8-page Paper 58 covers "Instrumentation By and With Controlled Volume Pumps.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

Circle **478** on inquiry card.

Pump. New 4-page bulletin describes and illustrates maker's magnetically-driven centrifugal pump, a fractional-hp. pump driven by rotating magnetic field instead of usual drive shaft.—Fostoria Pressed Steel Corp., Fostoria, Ohio.

Circle **479** on inquiry card.

STEAM

Steam Traps. New 4-page illustrated bulletin gives construction, specifications, pressures, and weights of maker's inverted-bucket type steam traps.—V. D. Anderson Co., 1935 W. 96 Street, Cleveland, Ohio.

Circle **480** on inquiry card.

Steam Strainer. New 4-page issue of "Engineering News" (Vol. 6 No. 1) features article on compact strainer for high-pressure steam applications.—Schutte and Koerting Co., 18 State Rd., Cornwells Heights, Bucks County, Pa.

Circle **481** on inquiry card.

AIR

Hot-wire Anemometers. New 6-page brochure describes maker's hot-wire anemometer system for quantitative measuring of turbulence spectra and intensity, correlation coefficients, average and instantaneous air stream velocities, etc.—Aero-Research Instrument Co., Inc., 1901 N. Hermitage Ave., Chicago, Ill.

Circle **482** on inquiry card.

Smoke Photometer. New 4-page Bulletin JM-1000 describes and illustrates maker's "Model JM-1000" forward-scattering smoke photometer.—Phoenix Precision Instrument Co., 3803 N. Fifth St., Phila., Pa.

Circle **483** on inquiry card.

Air Sampler. New 4-page Folder IH-2 describes and illustrates maker's high-volume air sampler that samples large volumes of air for analysis via filter papers.—Air Sampler Div., Staplex Co., 68-72 Jay St., Brooklyn, N. Y.

Circle **484** on inquiry card.

LEVEL

Bin Level Indicator. New 18-page illustrated catalog presents maker's line of automatic bin level indicators for bulk materials.—Bin-Dicator Co., 13946 Kercheval Ave., Detroit, Mich.

Circle **485** on inquiry card.

Liquid-level Indicators. New 20-page Bulletin WG1824 describes maker's complete line of remote liquid-level indicators for boilers, heaters, storage tanks and other vessels in power and industrial process plants.—Yarnall-Waring Co., Chestnut Hills, Phila. 18, Pa.

Circle **486** on inquiry card.

Level, Pressure Telemeter. New 8-page Bulletin 230-K10 describes ap-

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plication of "Chronoflo" telemetering for level control in reservoirs and elevated and ground storage, for pressure control in pump discharge lines, and for automatic pump control.—Builder-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle **487** on inquiry card.

VISCOSITY

Viscometer. New 22-page illustrated booklet "Solutions to Sticky Problems" describes application and maintenance of maker's "Synchro-Lectric" viscometer. Includes principles of rheology.—Brookfield Engineering Laboratories, Inc., 240 Cushing St., Stoughton, Mass.

Circle **488** on inquiry card.

Viscometers. New 6-page illustrated Bulletin V-1000E describes maker's viscometers for recording or recording-controlling viscosity in industrial plants.—Norcross Corp., Newton 58, Mass.

Circle **489** on inquiry card.

Ultrasonic Viscosimeter. New 2-page bulletin illustrates and describes maker's new ultrasonic viscometer for industrial and laboratory use.—Ultrasonic Engineering Co., P. O. Box 46, Maywood, Ill.

Circle **490** on inquiry card.

ANALYTICAL

Recording Spectrometer. New 4-page Bulletin 40-354 describes and illustrates maker's new recording spectrometer with multiplier-phototube detection of spectrum over a range of 2,100 to 7,000 A.—Leeds & Northrup, 4907 Stenton Ave., Phila., Pa.

Circle **491** on inquiry card.

Spectrographic Outfits. New 52-page catalog presents full line of spectrographic outfits and accessories for metallurgical and general chemical analyses. Includes apparatus and lab arrangements.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Circle **492** on inquiry card.

Moisture Measurement. New 4-page bulletin describes "Supertest 712" moisture-measuring instrument newly available in U.S. and Canada. Discusses "dielectric measuring principle" used.—Hygrotester, Inc., 101 Henry St., Brooklyn 1, N. Y.

Circle **493** on inquiry card.

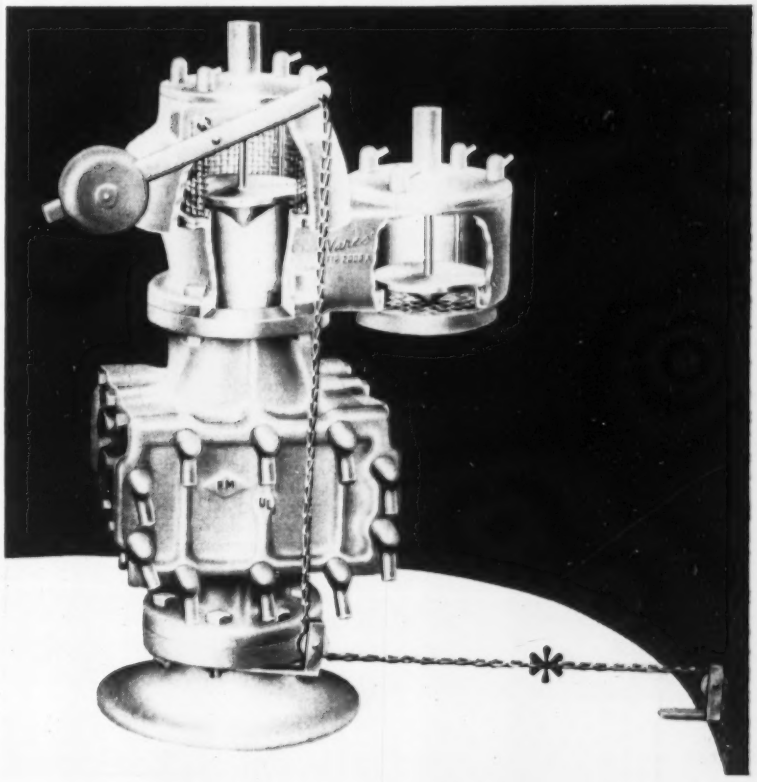
Electron-multiplier Photometer. New 12-page Bulletin 1001 EM presents features and applications of maker's electron-multiplier photometer for photometry and spectrophotometry in ultraviolet and visible regions, including film densitometry, colorimetry, etc.—Phoenix Precision Instrument Co., 3803-05 N. 5th St., Phila., Pa.

Circle **494** on inquiry card.

pH Meter. New 4-page Bulletin 225 presents maker's "Model 115" line-operated pH meter for laboratory work and process control.—Photovolt Corp., 95 Madison Ave., New York, N. Y.

Circle **495** on inquiry card.

Spectrophotometer. New 2-page illustrated brochure gives specifica-



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NEW LITERATURE

tions and principles of maker's "Model 61" spectrophotometer with wavelength range of 420 to 680 mu.—Harold Kruger Instruments, P. O. Box 164, San Gabriel, Calif.

Circle **496** on inquiry card.

Redox Control. New 4-page Bulletin 2210 presents applications, features, and description of maker's "Redox-O-Trol" for control of electrochemical reductions and oxidations.—American Instrument Co., Silver Spring, Md.

Circle **497** on inquiry card.

Conductance Tester. New 4-page Bulletin 2B describes maker's "Model 269 Vibrotest" instrument for measuring conductivity of hospital operating-room floors, personnel, and equipment to prevent electrostatic discharge.—Associated Research Inc., 3766 W. Belmont Ave., Chicago, Ill.

Circle **498** on inquiry card.

X-Ray Quantometer. New 2-page illustrated bulletin describes new "Model 10500" X-ray industrial "Quantometer", for production control applications.—Applied Research Laboratories, 3717 Park Pl., Glendale, Calif.

Circle **499** on inquiry card.

Recording Densitometer. New 2-page illustrated Bulletin 117 describes maker's manually operated recorder for rapid photometric analysis of light-absorbing materials on dry paper strips as obtained in electrophoresis and chromatography.—Arthur H. Thomas Co., 230 S. 7 St., Phila., Pa.

Circle **500** on inquiry card.

Spectrophotometer Recorder. New 10-page catalog describes and illustrates maker's new fully-automatic high-speed continuous-recording spectrophotometer.—Warren Electronics Inc., Bound Brook, N. J.

Circle **501** on inquiry card.

Chemical Analysis. New 28-page issue of "Chemist Analyst" (Vol. 43 No. 1) presents 10 articles and 11 laboratory suggestions for the analytical chemist.—J. T. Baker Chemical Co., Phillipsburg, N. J.

Circle **502** on inquiry card.

Ionographs. New 8-page Bulletin 690 illustrates and describes maker's "Junior" and "Senior" ionographs for electrophoresis. Includes application of ionography to biochemical investigations.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **503** on inquiry card.

LAB APPARATUS

Lab Apparatus. New 24-page 20th edition of "What's New for the Laboratory" features balance, colorimeters, circulator, filter paper, mixer, ovens, stirrer, etc.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Circle **504** on inquiry card.

Polyethylene Ware. New 8-page catalog presents maker's full line of Polyethylene laboratory ware.—Schaar & Co., 754 W. Lexington St., Chicago, Ill.

Circle **505** on inquiry card.

Laboratory Equipment. New 16-page Catalog EC-2 presents maker's line of educational laboratory equipment, including science desks, center tables, instructor's desks, etc.— Metalab Equipment Corp., 214 Duffy Ave., Hicksville, L. I., N. Y.

Circle **506** on inquiry card.

Glassware Washer. New 20-page illustrated catalog presents maker's line of laboratory glassware and animal cage washers.—Heinicke Instruments, 2035 Harding St., Hollywood, Fla.

Circle **507** on inquiry card.

WEIGHT

Weighing Machines. New 4-page Form 3287 pictures and describes automatic net weighing machine for packaging, bagging, batching, compounding plastics, food products, chemicals, powdered metals, etc.—The Exact Weight Scale Co., Columbus 8, Ohio.

Circle **508** on inquiry card.

Railroad Track Scales. New 14-page illustrated Catalog 685 describes heavy-duty four-section straight-lever railroad track scales.—Howe Scale Co., Rutland, Vt.

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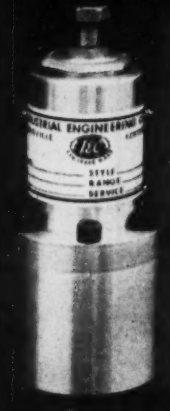

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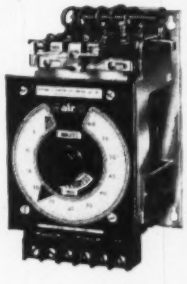

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FORCE

Dynamometers. New 4-page bulletin describes and illustrates maker's "Dyna-Chek" dynamometers for measuring electric motors of 2 hp. or less.—Mission-Western Engineers, Inc., 132 W. Colorado, Pasadena, Calif.

Circle **510** on inquiry card.

Dynamometers. New Broadside (16-page folder) Bulletin 25E presents specifications, prices, and typical applications of maker's 26 models of force-measuring instruments with ranges from 500 to 100,000 lbs.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle **511** on inquiry card.

VIBRATION, ACCELERATION

Accelerometer. New 2-page brochure describes and illustrates maker's "Model No. 6000" self-generating Accelerometer.—General Scientific Corp., 603 N. La Brea Ave., Los Angeles, Calif.

Circle **512** on inquiry card.

Microseismic Research. New 42-page operating manual gives instructions for installation, calibration, and operation of recording seismograph in microseismic research—the study of small vibrations in the earth.—W. F. Sprengnether Instrument Co., St. Louis 10, Mo.

Circle **513** on inquiry card.

Balancing Machines. New 4-page brochure presents maker's line of dynamic balancing machines—R. B. Annis Co., 1101 N. Delaware St., Indianapolis, Ind.

Circle **514** on inquiry card.

COMPUTERS

Analog Computer. New 4-page brochure illustrates and describes maker's new "Type 16-31 R" self-contained analog computer with 20 operational amplifiers.—Electronic Associates Inc., Long Branch, N. J.

Circle **515** on inquiry card.

Square-root Planimeter. New 2-page bulletin pictures and describes desk-size mechanical analog computer for flow chart totalizing and cost accounting of 3-inch graphic-panel strip-chart recorders.—Librascope, Inc., 1607 Flower St., Glendale, Calif.

Circle **516** on inquiry card.

Electronic Computer. New 4-page Bulletin CEC-3100 presents maker's "Model 30-203" electronic general-purpose digital computer featuring quick-access memory.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **517** on inquiry card.

Digital Computers. New 12-page booklet presents description and specifications of maker's "Circle" high-speed digital computers. Includes orders, codes, etc.—Hogan Laboratories, Inc., 155 Perry St., New York, N. Y.

Circle **518** on inquiry card.

Electronic Data Storage. New 4-page pamphlet describes "Magnetic Library System" (digital computer,

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NEW LITERATURE

memory wheel, office machines) for use in accounting, production and inventory control, etc.—Logistics Research Inc., 141 S. Pacific Ave., Redondo Beach, Calif.

Circle **519** on inquiry card.

Analog-to-Digital Converter. New 14-page booklet describes and illustrates maker's "Reacon" high-speed analog-to-digital converter.—J. B. Rea Co., 1723 Cloverfield Blvd., Santa Monica, Calif.

Circle **520** on inquiry card.

Analog Computer. New 2-page brochure describes maker's "Model MK" electronic analog computing instrument for applications requiring up to 4 operational amplifiers.—George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.

Circle **521** on inquiry card.

Analog Computers. New 14-page catalog describes and illustrates maker's new "C-301" and "C-302" portable desk-top electronic analog computers.—Reeves Instrument Corp., 215 East 91 St., New York, N. Y.

Circle **522** on inquiry card.

TIMING, COUNTING

Electric Counters. New 2-page illustrated Bulletin 502 describes "Model SP" predetermined electric counter impulse-actuated to close or open switch at preset count (1 to 99,999). —Durant Mfg. Co., 1929 N. Buffum St., Milwaukee, Wis.

Circle **523** on inquiry card.

Repeat Cycle Timer. New 2-page Bulletin 353 describes and illustrates maker's "Model 2" and "Model 3" repeat cycle timers for intervals from 0.01 to 900 seconds.—G. C. Wilson & Co., 1950 Eighth Ave., Huntington, W. Va.

Circle **524** on inquiry card.

Timers in Automation. New 12-page booklet describes reset and repeating-cycle type timers for use in machines for automatic handling, machining, or processing.—Eagle Signal Corp., Moline, Ill.

Circle **525** on inquiry card.

Timers, Thermometers. New 2-page brochure describes and illustrates maker's line of testing instruments, including timers, thermometers, pressure gages and soundscopes, designed particularly for service men.—Marsh Instrument Co., Skokie, Ill.

Circle **526** on inquiry card.

Down-time Recorders. New 8-page brochure describes and illustrates maker's full line of recorders for industrial down-time and motion studies. Includes mechanical and electrical models.—The Service Recorder Co., 1375 Euclid Ave., Cleveland, Ohio.

Circle **527** on inquiry card.

GAGING, INSPECTION

Surface Roughness. New 8-page illustrated bulletin describes in-plant demonstration service on maker's "Profilometer" for measuring surface roughness. Tells how to arrange for demonstration.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **528** on inquiry card.

Testing Machines. New 4-page Bulletin 4213 describes maker's universal testing machines of 20,000- and 60,000-lb. capacity.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **529** on inquiry card.

Gage Blocks. New 2-page brochure illustrates and describes maker's "Ultra-chex" gage blocks, angle plates, measuring iron, and other tool-room equipment.—George Scherr Co., Inc., 200 Lafayette St., New York, N. Y.

Circle **530** on inquiry card.

Comparator. New 2-page Bulletin 191-53 describes maker's "M1233" coordinate comparator for measurement and evaluation of photographic plates, and for linear and coordinate measurements of photographic records.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.

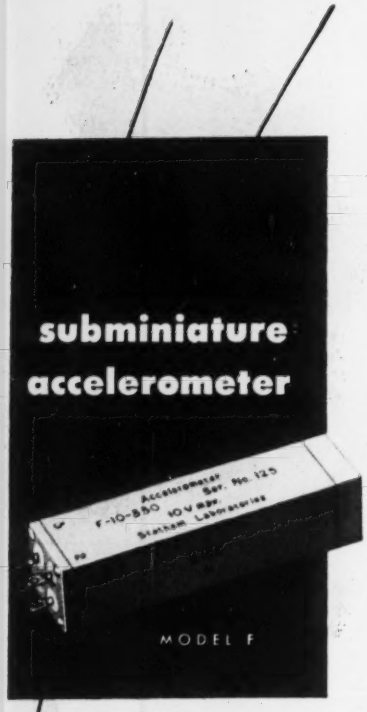
Circle **531** on inquiry card.

Optical Comparator. New 12-page brochure presents maker's "Model R-300" optical comparator.—Portman Instrument Co., Town Dock Rd., New Rochelle, N. Y.

Circle **532** on inquiry card.

Optical Comparator. New 2-page bulletin illustrates and describes maker's new optical comparator designed for mass production inspection. —Tecna Products Co., 15 Whitehall St., New York, N. Y.

Circle **533** on inquiry card.



To detect and measure static or dynamic acceleration in ranges from ±2 g to ±100 g, the Model F accelerometer is available for applications requiring miniature components.

Weighing less than one ounce, this accelerometer can be attached to light machine parts without altering their dynamic performance, or it may be inserted into small spaces previously inaccessible for vibration measurements. At no sacrifice in performance, extremely small size and weight are emphasized in the Model F accelerometer.

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105-125 V. 60C INPUT
OUTPUT CURRENT MAY BE SET AT ANY VALUE FROM 0.2 TO 50 M.A. D.C.
AS LOAD VOLTAGE VARIES BETWEEN 0-150 V. MODEL IA-R IS CONSTANT WITHIN 1%, MODEL IB-R WITHIN 0.1%.

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For more information circle **154** on inquiry card.

Interferometer. New 6-page brochure describes and illustrates maker's Penn-modified "Twyman-Green" interferometer for inspection and testing involving light transmission through inhomogenous media or reflectance at surfaces that are not precisely plane.—Penn Optical & Instrument Co., 50 So. San Gabriel Blvd., Pasadena, Calif.

Circle **534** on inquiry card.

Inspection Magnifier. New 2-page bulletin describes and illustrates maker's rectangular illuminated inspection magnifier for examination of large parts.—Esco Products, 1428 Willow Ave., Hoboken, N. J.

Circle **535** on inquiry card.

RADIOACTIVITY

Radiation Instruments. New 20-page Catalog Form 3017-A presents maker's large line of radiation-measuring equipment, including dosimeters, health survey, and isotope laboratory instruments.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland, Ohio.

Circle **536** on inquiry card.

Radioactivity Instruments. New 18-page catalog presents maker's line of radioactivity instruments, including detecting devices, counter-tube shields, and protective handling equipment.—El-Tronics, Inc., Fifth and Noble St., Phila., Pa.

Circle **537** on inquiry card.

Industrial Radiography. New 28-page illustrated Booklet A-5982 describes maker's full line of x-ray films, chemicals, and screens for industrial use. Presents characteristic curves, technique charts, speed and detail data.—E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Dela.

Circle **538** on inquiry card.

Isotope Instruments. New 8-page bulletin describes and illustrates maker's isotope instruments for transporting, counting, measurement, storage, and administration of radioactive isotopes.—Isotope Accessories Co., Box 5458, Phila. 43, Pa.

Circle **539** on inquiry card.

Radioactivity Survey. New 2-page bulletin describes "Royal Scintillator" ratemeter for surface and airborne oil field surveys.—Precision Radiation Instruments, Inc., So. La Brea Ave., Los Angeles, Calif.

Circle **540** on inquiry card.

OPTICS

Precision Optics. New 15-page brochure presents facts concerning maker's personnel, history, equipment, capabilities and objectives. Designed to enable reader to determine products and services which maker can supply.—Wm. I. Mann Co., 116 W. Foothill Blvd., Monrovia, Calif.

Circle **541** on inquiry card.

Optical Instruments. New 12-page brochure pictures and describes optical comparators, microscopes, spectroscopes, reticles, pen microscopes, and tool, camera and instrument accessories.—Edmund Scientific Corp., Barrington 5, N. J.

Circle **542** on inquiry card.

Pneumatic Weight Transmitters

FOR LINEAR CONVERSION OF WEIGHT INTO POUNDS PER SQUARE INCH AIR PRESSURE

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

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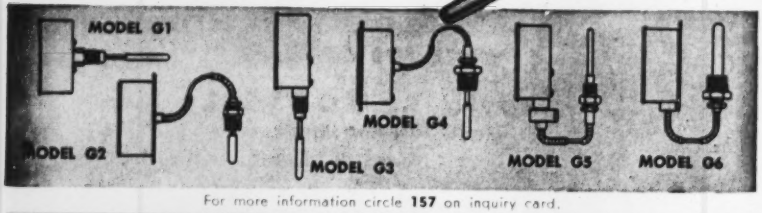

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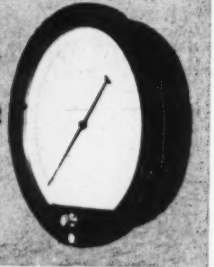

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NEW LITERATURE

Dry Duplicating Equipment. New 6-page brochure describes and illustrates maker's "Thermo-Fax" line of duplicating equipment for correspondence, records, charts and drawings, which uses only thermally-sensitive paper—no chemicals, no washing, no processing.—Magna-Crest Corp., 730 Fifth Ave., New York, N. Y.

Circle **543** on inquiry card.

Surveying Camera. New 28-page bulletin is reprint for Dec. 1953 "Photogrammetric Engineering" by E. L. Merritt on principles of design and applications of "MM 101" surveying camera.—Photogrammetry, Inc., Silver Spring, Md.

Circle **544** on inquiry card.

Optical, Research Instruments. New 4-page illustrated brochure presents specifications of maker's line of custom-engineered scientific research instruments, including astrophotometers, goniometers, and apparatus for nuclear physics.—L. C. Eichner Instruments, 19 Sebago St., Clifton, N. J.

Circle **545** on inquiry card.

Projection Pointer. New 4-page booklet presents description and applications of maker's electric projection pointer.—Ednalite Optical Co., 220 N. Water St., Peekskill, N. Y.

Circle **546** on inquiry card.

Dry Duplicator. New 4-page Bulletin TF-HOW (1035) describes and illustrates maker's dry photo-copying process.—Thermo-Fax Div., Minnesota Mining & Mfg. Co., St. Paul 6, Minn.

Circle **547** on inquiry card.

MAGNETICS

"Vibralloy." New 4-page bulletin presents information about "Vibralloy," ferromagnetic alloy of molybdenum, nickel, and iron with controllable modulus of elasticity.—Arnold Engineering Co., Marengo, Ill.

Circle **548** on inquiry card.

Permanent Magnets. New Vol. 2 No. 2 issue of "Applied Magnetics" presents illustrated article on cost-cutting via products incorporating permanent magnets.—The Indiana Steel Products Co., Valparaiso, Ind.

Circle **549** on inquiry card.

ELECTRONIC INSTRUMENTS

Test Instruments. New 64-page second edition of Catalog GEC-1016A describes and illustrates measuring equipment for laboratory and production testing including electric-circuit test equipment, high voltage a-c. and d-c. testing equipment, magnetic-field equipment, force and strain gages, and radiation instruments.—General Electric Co., Schenectady, N. Y.

Circle **550** on inquiry card.

Test Instruments. New 12-page Catalog 5401 describes and illustrates maker's full line of precision laboratory test instruments including Q indicators, limit bridges, a-c. vacuum tube voltmeters, decade capacitors,

ete.—Freed Transformer Co., 1718 Weirfield St., Brooklyn, N. Y.

Circle **551** on inquiry card.

Oscilloscopes. New 24-page handbook presents basic characteristics of oscilloscope, how it works, and tips on general use.—Hickok Electric Instrument Co., 10519 Dupont Ave., Cleveland, Ohio.

Circle **552** on inquiry card.

Resistance Meter. New 4-page brochure describes and illustrates maker's new "Model C6" resistance meter with ranges to 10 million megohms.—Southwestern Industrial Electronics Co., 2831 Post Oak Rd., P. O. Box 13058, Houston 19, Tex.

Circle **553** on inquiry card.

Pulse Measurements. New 24-page issue of "The Oscillographer" (Vol. 14, No. 3) features article on "Techniques in Pulse Measurements."—Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **554** on inquiry card.

Pulse Instruments. New 4-page Bulletin 1-53 illustrates and describes maker's line of multi-purpose pulse instruments. Includes time delay and gate generators and pulse generators.—Electro-Pulse, Inc., 11811 Major St., Culver City, Calif.

Circle **555** on inquiry card.

Frequency Meter. New 2-page Bulletin 5570 presents maker's new "Model 5570" frequency meter, capable of measuring and indicating in digital form frequencies from 0 to 42 Mc.—Beckman Instruments Inc., 2200 Wright Ave., Richmond, Calif.

Circle **556** on inquiry card.

Portable Wattmeters. New 8-page issue of "Weston Engineering Notes" (Vol. 9 No. 1) features article on maker's "Model 905" a-c., d-c. portable wattmeters.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Circle **557** on inquiry card.

Universal Test Set. New 8-page issue of "Electrical Measurements" (Vol. 21, No. 1) describes and illustrates maker's universal measuring test set for d-c. measurement of voltage and current to accuracy of 0.5 percent, and with over 200 separate ranges.—Sensitive Research Instrument Corp., Mount Vernon, N. Y.

Circle **558** on inquiry card.

Angle Meter, Phase Meter. New 4-page "TIC Laboratory Report No. 9" features applications of "Type 310-A" phase meter. Includes representative experiments, and suggests methods of use for certain instruments to simplify common electrical measurements.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **559** on inquiry card.

Vacuum-tube Electrometers. New 8-page catalog describes and illustrates maker's vacuum-tube electrometers for high-impedance measurements; also electrometer voltage dividers, electrometer shunt, and test voltage supply.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.

Circle **560** on inquiry card.

SWR Indicator. New 4-page bulletin presents maker's instantaneous broad-band direct-reading SWR indicators, which cover frequencies from 400 to 1350 Mc.—Airborne Instruments Laboratory, Inc., Mineola, L.I., N. Y.

Circle **561** on inquiry card.

Plug-in Circuits. New illustrated 12-page Catalog C-3 describes packaged plug-in units for various basic circuits; includes diagrams.—Electronic Engineering Co. of Calif., 180 S. Alvarado St., Los Angeles, Calif.

Circle **562** on inquiry card.

Electronic Kits. New 8-page Spring Flyer illustrates and describes "Heathkit" oscilloscope, voltmeter, bridges, battery eliminators, and other electronic equipment kits.—Heath Co., Benton Harbor, Mich.

Circle **563** on inquiry card.

POWER SUPPLIES

Regulated Power Supplies. New 32-page Catalog 254 presents principles, specifications, and pictures of a-c. voltage regulators, regulated d-c. sources and "B-supplies," frequency (60 to 400 cps.) changers, inverters, and "Nobatron" high-current regulated d-c. sources.—Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

Circle **564** on inquiry card.

Transistorized Power Packs. New 2-page bulletin illustrates and describes maker's new transistorized "Transpac" power packs.—Electronic Research Associates, Inc., Box 29, Caldwell, N. J.

Circle **565** on inquiry card.

Power Supplies. New 8-page catalog describes and illustrates maker's complete line of electronic and electromechanical devices, power supplies, dry batteries, and telecommunications equipment. Also facilities for production of electronic and electromechanical devices.—Allied International Inc., 230 Park Ave., New York, N. Y.

Circle **566** on inquiry card.

DC Laboratory Standard. New 4-page brochure describes maker's new "Model BS" self-checking direct-current laboratory standard volt-amp-milliammeter, which measures with accuracy of 0.05 percent.—Sensitive Research Instrument Corp., Mt. Vernon, N. Y.

Circle **567** on inquiry card.

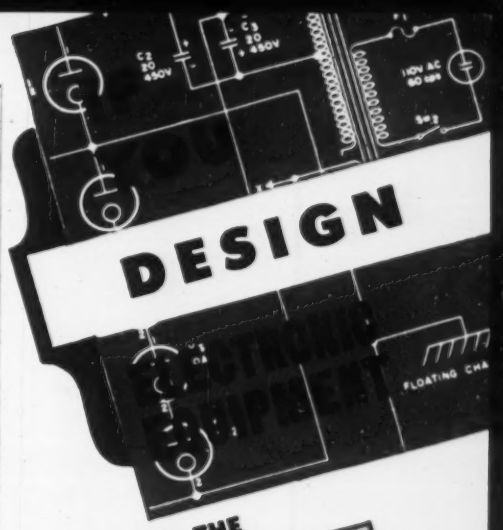
Modular Electronics. New 6-page folder illustrates and describes maker's "Reliacube," a compact electronic package element featuring new modular design.—Sanders Associates, Inc., Nashua, N. H.

Circle **568** on inquiry card.

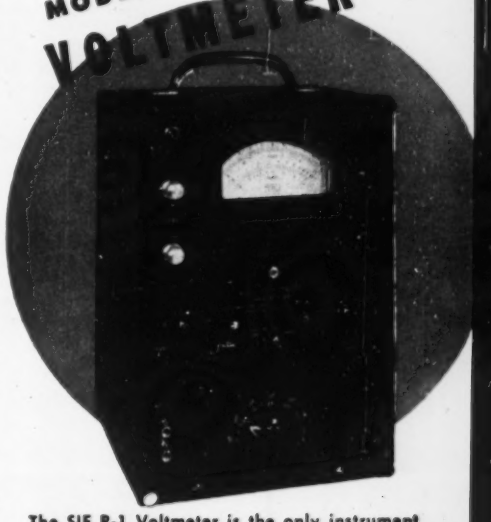
Electronic Test Equipment. New 4-page illustrated brochure presents distributor's electronic and sound equipment, including connectors, hydrogen thyratron tubes, switches.—Hudson Radio and Television Corp., 48 West 48 St., New York, N. Y.

Circle **569** on inquiry card.

4-channel Cathode Follower. New illustrated 2-page brochure gives



YOU NEED THE SIE MODEL R-1 AC-DC VOLTMETER



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These high pressure transmitters incorporate a unique direct coupling arrangement between bourdon tube and potentiometer element which obtains movement amplification without the use of gearing or linkage, thus giving high sensitivity, repeatability, and low hysteresis.

Ranges from 0-100 psi. to 0-6500 psi., (abs., diff., gage). Instruments are available for operation under either normal or extreme conditions of vibration and acceleration or for corrosive media.

Other models also available for low pressure and high altitude applications. Write for complete engineering information.

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NEW LITERATURE

specifications of maker's "Model TG-1" 4-channel cathode-follower for instrumentation.—G. W. Associates, P.O. Box 2263, El Segundo, Calif.

Circle **570** on inquiry card.

Airborne Electronic Equipment. New 6-page brochure pictures and describes voltage "Sensitometer" for monitoring voltage-sensitive equipment, "Pulsitometer" for monitoring malfunction, "Intervalometer" for sequence control, and other aircraft-rocket-missile devices.—Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, Calif.

Circle **571** on inquiry card.

Electrical Test Equipment. New 20-page Catalog 19B presents megohm meters, voltage testers, bridges, resistance decades, noise tester, etc.—Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.

Circle **572** on inquiry card.

VTVM. New 4-page brochure presents features of "MV-17C" d-c. VTVM with ranges from 1 mv. to 1000 v.; "MV-15C" millivoltmeter with ranges from 10 uv. to 1 v.; and "MV-11B" micro-microammeter with ranges from 165 uua. to 1 ma.—Millivac Instrument Corp., P. O. Box 997, Schenectady, N. Y.

Circle **573** on inquiry card.

Digitester, Digitohm. New 2-page bulletin presents maker's "Digitester Type 48A" which measures resistance, voltage, and current with laboratory standard accuracy and supplies direct-reading digital output. Also describes Digitohm "Type 47A" for resistance measurement.—Telecomputing Corporation, 133 E. Santa Anita Ave., Burbank, Calif.

Circle **574** on inquiry card.

Q Standard. New 2-page brochure illustrates and describes maker's new "Type 513-A" Q standard which provides an accurately known Q and reactance for precise measurements.—Boonton Radio Corp., Boonton, N. J.

Circle **575** on inquiry card.

Impedance Measurement. New 8-page Bulletin 777-c presents maker's "Type 1602-B" UHF admittance meter for measurement of impedance, admittance, and VSWR at frequencies between 41 and 1500 Mc.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

Circle **576** on inquiry card.

Transconductance Analyzer, Circuit Simulator. New 2-page preliminary spec sheet describes maker's "Model 901" transconductance analyzer and circuit simulator, a direct reading vacuum-tube transconductance meter.—New London Instrument Co., P. O. Box 189, New London, Conn.

Circle **577** on inquiry card.

Electrostatic Charge. New 2-page illustrated Bulletin 123 describes maker's "Statigun," a portable instrument for measuring electrostatic charges on surfaces.—Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.

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Parabolic, Spherical, Ellipsoidal and Plane Mirrors

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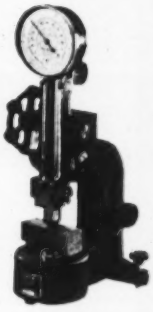

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Illustrated bulletins free

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Jamaica 35, N. Y.

For more information circle **162** on inquiry card.

Test Equipment, Switches. New 16-page Spring Issue catalog describes electrical test equipment, timers, components, valves, contactors, breakers, and other equipment available from—Herbach & Rademan Inc., 1204 Arch St., Phila., Pa.

Circle **579** on inquiry card.

Radio Telemetering. New 16-page booklet covers "Standard Pulse Width Radio Telemetering—New Developments and Applications."—ASCOP, P. O. Box 44, Princeton, N. J.

Circle **580** on inquiry card.

FM Signal Generator. New 4-page illustrated booklet describes new "Model ASG-1" precision FM signal generator with range from 20 to 100 Mc.—A.R.F. Products, Inc., 7627 Lake St., River Forest, Ill.

Circle **581** on inquiry card.

DC Supply. New 4-page brochure describes and illustrates maker's new "Model PS-503" 5,000-volt d-c. power supply.—Servo Corp., of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.

Circle **582** on inquiry card.

DC Power Supplies. New 4-page Bulletin MA154 presents maker's magnetic-amplifier regulated d-c. power supplies. Companion 2-page Bulletin T354 covers maker's transformers, filter chokes, and magnetic amplifiers.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **583** on inquiry card.

POTENTIOMETERS

Potentiometer Handbook. New 207-page handbook presents detailed treatment of nearly all phases of potentiometer (VDR) theory, design, performance, and application. Price $2.00. —Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **584** on inquiry card.

Precision Potentiometer. New 14-page brochure illustrates and describes maker's five new types of precision potentiometers, including sine-cosine, 10-turn helical, new "Filmpot," and linear pots.—Fairchild Camera and Instrument Corp., 225 Park Ave., Hicksville, N. Y.

Circle **585** on inquiry card.

Multiturn Potentiometers. New 8-page Catalog BED-18 illustrates and describes maker's line of precision multiturn "Micropot" potentiometers. —George W. Borg Corp., 120 S. Main St., Janesville, Wis.

Circle **586** on inquiry card.

Precision Potentiometers. New 6-page issue of "Helinews" No. 5 features article on Shand & Jurs level-gage system using precision potentiometers as pickups.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **587** on inquiry card.

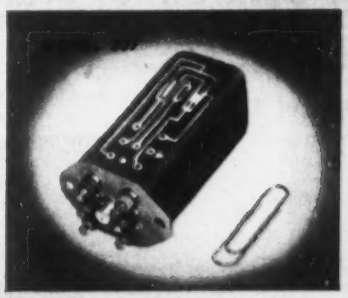
Translation Potentiometer. New 2-page bulletin presents description, specifications and diagrams of maker's "Model G" linear translation potentiometer for instrument service.—Servonic Instruments, Inc., 1145 S. Fair Oaks, Pasadena, Calif.

Circle **588** on inquiry card.

THE NEW ELECTRONIC CHOPPER by AVION

all electrical!

no moving parts!



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- **HIGH INPUT IMPEDANCE**

The *completely new* design of this Avion Chopper provides for 100% electronic operation . . . achieved by modulation of D.C. voltages by alternate illumination at line frequency . . . of the photoconductive element in a voltage divider.

Compact, light, and durable, this unit is ideal for conversion of D.C. and A.C. in the fields of servomechanisms, computing devices; D.C. null measurement circuits, and other electronic control systems.

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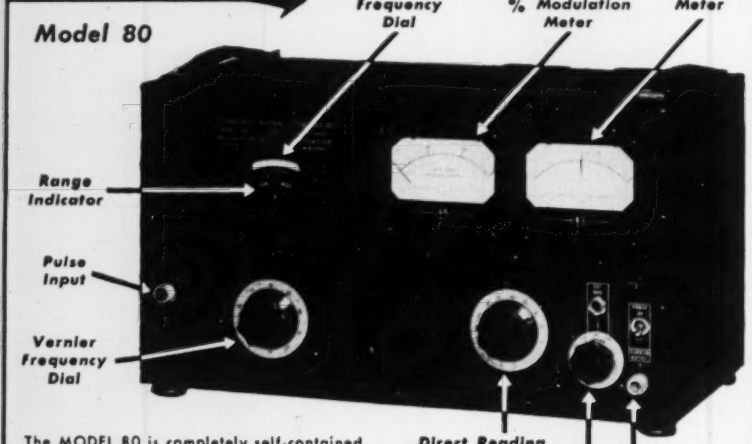
STANDARD SIGNAL GENERATOR

2 Mc. - 400 Mc.

Model 80



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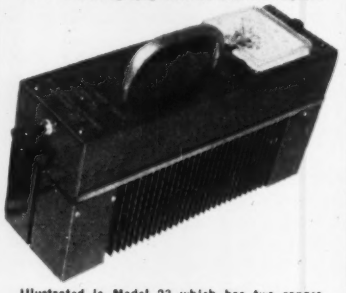
There have been many discussions of the toxic nature of mercury vapor in the technical literature. A bibliography will be sent on request.



Illustrated is Model 23 which has two ranges for versatility. The toxic limit for extended exposure is full scale on the high sensitivity range. Together the ranges provide coverage of concentrations from 0.005 to 3.0 mg. cu. m. Dimensions of all models are 13"x8½"x4½".

Model	Feature	Range	Weight
21	low cost	0.03 to 3	5 lbs.
23	dual range	0.005 to 0.1 0.03 to 3	7 lbs.
24	alarm	0.005 to 0.1 0.03 to 3	8 lbs.

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NEW LITERATURE

Low-torque Potentiometers. New 4-page brochure describes and illustrates maker's new ultra-low-torque precision function potentiometers.—Electro-Mec Laboratory, Inc., 21-09 43 Ave., L. I. C. 1, N. Y.

Circle **589** on inquiry card.

Film Potentiometer. New 2-page bulletin presents specs of maker's new "Pot-100" film potentiometer with infinite resolution.—Servomechanisms, Inc., 316 Washington St., El Segundo, Calif.

Circle **590** on inquiry card.

Resistors, Rheostats. New 28-page catalog describes maker's line of wirewound fixed and adjustable vitreous-enamel power resistors and power rheostats.—P. R. Mallory & Co. Inc., Frankfort, Ind.

Circle **591** on inquiry card.

SWITCHES, RELAYS

Electrostictive Capacitive Relay. New 2-page illustrated bulletin is advance information on maker's new "Capaswitch" relay that uses electrostrictive capacitive element to transfer contacts, providing an ultrasensitive (0.5 mw.-sec.) relay of new principle.—Mullenbach Electrical Mfg. Co., P. O. Box 15436, 2300 E. 27 St., Los Angeles, Calif.

Circle **592** on inquiry card.

Circuit Scanner. New 2-page bulletin illustrates and describes maker's new "Type 42A" and "Type 42B" circuit scanner for multiple channel sampling.—Telecomputing Corp., Burbank, Calif.

Circle **593** on inquiry card.

Precision Switches. New 36-page Catalog 98 describes and illustrates the maker's precision snap-action switches.—Acro Mfg. Co., Columbus 16, Ohio.

Circle **594** on inquiry card.

Automatic Transfer Switch. New illustrated Bulletin 502 describes in detail the factors to look for in selecting an automatic transfer switch to transfer loads from normal power supply to emergency supply.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle **595** on inquiry card.

Toggle Switches. New 12-page Catalog 73a presents maker's line of precision snap-action toggle assemblies, including assemblies that will control form 1 to 24 separate electric circuits. —Micro Switch, Freeport, Ill.

Circle **596** on inquiry card.

Miniature Relays. New 4-page brochure presents line of dynamically and statically balanced miniature relays. —S. H. Couch Co., Inc., North Quincy 71, Mass.

Circle **597** on inquiry card.

TRANSISTORS, TUBES

Surface barrier Transistor. New 16-page booklet presents five papers on the surface-barrier transistor, includ-

ing principles, fabrication, and performance.—Philco Corp., Phila. 44, Pa.

Circle **598** on inquiry card.

Transistors. New 2-page Bulletin DL-S 407 illustrates and describes maker's line of semiconductor devices, including silicon junction diodes, new power transistors, phototransistors, new junction tetrode transistors and point-contact transistors.—Texas Instruments Inc., 600 Lemmon Ave., Dallas, Tex.

Circle **599** on inquiry card.

Power Transistor. New 2-page Bulletin RD53-002 presents characteristic curves of maker's "2N57" power transistor now available in quantity.—Minneapolis-Honeywell Regulator Co., Minneapolis 8, Minn.

Circle **600** on inquiry card.

Tetrode Transistors. New preliminary Data Sheet describes experimental grown junction tetrode transistors for high-frequency oscillators and amplifiers.—Germanium Products Corp., 26 Cornelison Ave., Jersey City, N. J.

Circle **601** on inquiry card.

Power, Thyratron Tubes. New 578-page loose-leaf catalog is reference-record of maker's complete line of power tubes, rectifier tubes, thyratrons, magnetrons, and vacuum capacitors. Includes specific detail charts, illustrations and descriptions. Write on company letterhead.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N. Y.

Circle **602** on inquiry card.

ELECTRONIC COMPONENTS

60-cycle Choppers. New 4-page bulletin describes and illustrates maker's new line of d-c. and a-c. 60-cycle choppers for instrument use.—Stevens Arnold Inc., 22 Elkins St., South Boston 27, Mass.

Circle **603** on inquiry card.

400-cycle Choppers. New 4-page bulletin and two 2-page inserts describe and illustrate maker's new 400-cycle and 60-cycle choppers.—Airpax Products Co., Middle River, Baltimore 20, Md.

Circle **604** on inquiry card.

Delay Line. New 2-page bulletin illustrates and describes maker's distributed-constant delay line with delay of ½ usec. per ft.—General Electric, 1811 LeMoyne Ave., Syracuse, N. Y.

Circle **605** on inquiry card.

Delay Lines. New 2-page bulletin presents maker's new "Helidel" continuously variable distributed-constant type electromagnetic delay line with delays to 0.2 microsecond in increments of 0.02 millimicrosecond.—Helipot Corp., S. Pasadena, Calif.

Circle **606** on inquiry card.

Multi-diode Unit. New 2-page brochure presents specifications and applications of maker's multi-diode plug-in unit with banks of 8, 12, or 16 diodes.—Electronic Engineering Co., 180 S. Alvarado St., Los Angeles, Calif.

Circle **607** on inquiry card.

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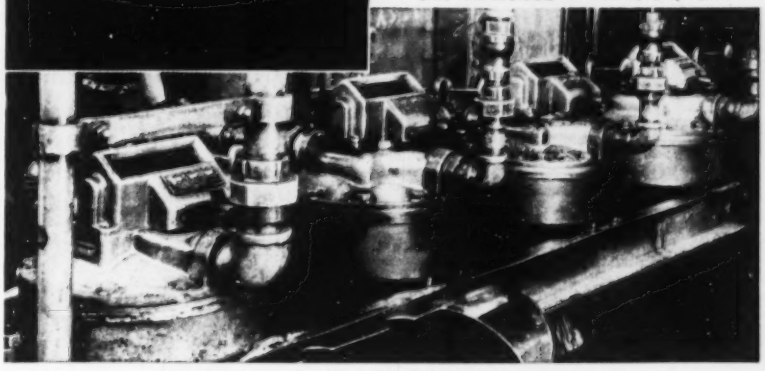

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performance approaching MIL Specs at commercial-spec prices.

Die-cast aluminum frames and end brackets—shielded ball bearings in cast-in stainless-steel inserts—rugged stainless-steel shaft — 11-slot armature and commutator — silver-graphite brushes — molded barriers on terminal boards — speed range 50 to 5000 RPM — output voltage at constant ambient temperature is lineal with speed ±1%—at constant speed, voltage in either direction is the same within ±0.5 V —flange and flat mounting. Photo shows Frames (top to bottom) L-24, M-24, M-22.

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M-24-012†	1 ± 10%	60 Ohms	4%	2½ x 3⅛	20 oz.
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*With 10,000 Ohm Load. **Nominal Value; Tolerance ±20%.
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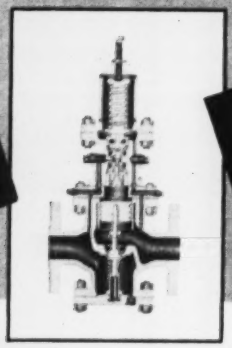

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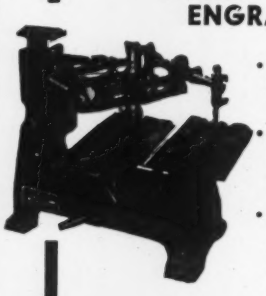

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NEW LITERATURE

Rectifiers. New 4-page issue of "International Rectifier News" features article on selenium rectifiers for magnetic amplifiers.—International Rectifier Corp., 1525 East Grand Ave., El Segundo, Calif.

Circle **608** on inquiry card.

Electronic Components. New 20-page Catalog 53-A describes and illustrates maker's full line of electronic components—switches, plugs, hardware, etc.—Herman H. Smith, Inc., 2326 Nostrand Ave., Brooklyn, N. Y.

Circle **609** on inquiry card.

Capacitors. New 48-page Catalog AC-4 presents description of maker's complete line of capacitors for radio and electronic applications. Includes electrolytic, paper, plastic, and metallized paper types; also r-f. filters.—Astron Corp., 255 Grant Ave., East Newark, N. J.

Circle **610** on inquiry card.

Connectors. New 4-page brochure describes and illustrates maker's new line of compression-loaded-contact miniature connectors.—Circon Component Co., 17544 Raymer St., Northridge, Calif.

Circle **611** on inquiry card.

Connectors. New 2-page brochure presents photographs, diagrams and specifications of maker's "Series E-Z 16" precision connectors with spring-loaded release, 12 contacts, plus two coaxial contacts.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C. 1, N. Y.

Circle **612** on inquiry card.

Miniature Connectors. New 2-page bulletin presents maker's "Series C-20" high-voltage single-contact cable and panel connector and "Series FHL" subminiature single contact connector.—DeJur-Amsco Corp., 45-01 Northern Blvd., L. I. C., N. Y.

Circle **613** on inquiry card.

Transformers. New illustrated 32-page catalog presents audio, driver, power, bias, filament, and other transformers.—Thermador Electrical Mfg. Co., Inc., 5119 District Blvd., Los Angeles, Calif.

Circle **614** on inquiry card.

Insulated Chokes. New 4-page Bulletin H-1 presents data on new sizes and extended ranges, construction, insulation, humidity, aging, applications and color coding of maker's line of insulated chokes.—International Resistance Co., 401 N. Broad St., Phila., Pa.

Circle **615** on inquiry card.

Miniature Inductors. New 2-page bulletin describes maker's "Type SL 2" miniature inductors in size ranges from 2.2 to 220 millihenries.—Mico Instrument Co., 86 Trowbridge St., Cambridge, Mass.

Circle **616** on inquiry card.

Coils, Toroids, Filters. New 14-page Catalog 102-A illustrates and describes maker's line of coils, toroids and filters. Includes standard and miniature toroids, coils for higher frequency applications and sideband and communications filters.—Burnell & Co., Yonkers 2, N. Y.

Circle **617** on inquiry card.

Toroids. New 4-page brochure illustrates and describes maker's line of toroidal coils and components. Includes miniature magnetic-amplifier coil and high-temperature coils.—Torwico Electronics, Inc., Newark 5, N. J.

Circle **618** on inquiry card.

Saturable Reactors, Transformers. New 6-page Bulletin 54S describes and illustrates maker's line of transformers, saturable reactors, chokes, special windings, and electronic devices.—The Electran Mfg. Co., 1901 Clybourn Ave., Chicago, Ill.

Circle **619** on inquiry card.

Contacts and Assemblies. New 60-page Form 3-11 on electrical contacts and contact assemblies, features "Contact Material Selector Guide" which describes materials, gives applications and advantages.—P. R. Mallory & Co., Inc., Contact Div., Indianapolis 6, Ind.

Circle **620** on inquiry card.

TUBING

Plastic Tubing. New 4-page bulletin describes "Cobon" transparent flexible plastic tubing for laboratory, medical, industrial, use. Lists sizes, chemical resistance data.—Couse & Bolton Co., 42-46 Lafayette St., Newark 2, N. J.

Circle **621** on inquiry card.

Aluminum Conductors. New 20-page illustrated booklet, "Research and Progress in Electrical Conductors," includes technical reference material on aluminum conductors.—Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh, Pa.

Circle **622** on inquiry card.

Steel Tubing. New 4-page Bulletin 151 presents mechanical and physical properties, bending, welding and heat treatment of maker's steel pipe and tubing.—The Babcock and Wilcox Co., Beaver Falls, Pa.

Circle **623** on inquiry card.

SHOP EQUIPMENT

Tapping Machine. New 4-page Bulletin T-54 illustrates and describes maker's precision, small-hole-tapping machine, incorporating a number of changes.—The Hamilton Tool Co., Ninth St. at Hanover, Hamilton, Ohio.

Circle **624** on inquiry card.

Tapping Machine, Armature Winder. New 6-page folder describes and illustrates distributor's "Froitheim & Rudert" automatic armature-winding machine and automatic tapping machine.—Rex Rheostat Co., 3 Foxhurst Rd., Baldwin L. I., N. Y.

Circle **625** on inquiry card.

Instrument Vise. New 2-page bulletin illustrates and describes maker's "Univise" for precision manufacturing and general use.—Picco Instruments & Controls Corp., 3593 Hayden Ave., Culver City, Calif.

Circle **626** on inquiry card.

Bellows. New 16-page Catalog 140 covers design, applications and specifications for "Flexon" bellows of stainless steel, monel, brass and other metals.—Flexonics Corp., 1337 South Third Ave., Maywood, Ill.

Circle **627** on inquiry card.

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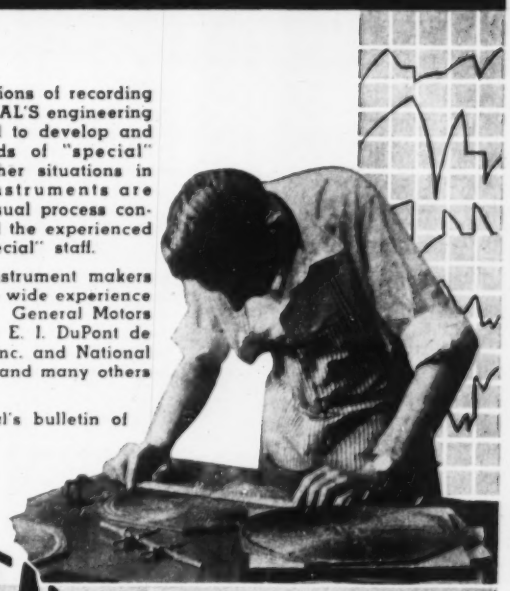

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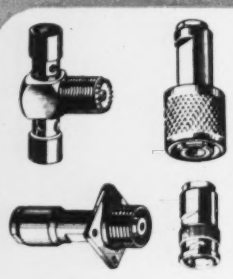

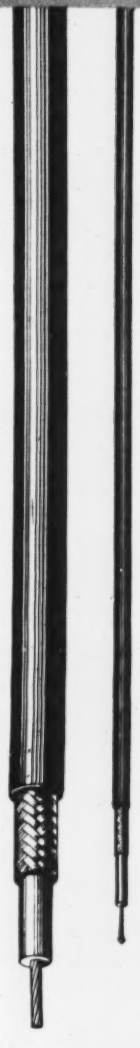

Yes, in a way, a second helping—for we are trying to express the factors which have helped raise the AMERICAN PHENOLIC CORPORATION by its boot straps in a little over twenty years. In the early thirties AMPHENOL was just another struggling industrial infant in one small factory and our main concern then was radio sockets. Today there are five modern plants producing over 11,000 cataloged products ranging all the way from AN connectors to television antennas.

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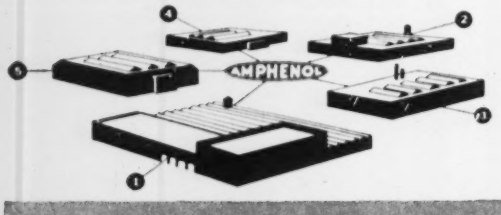

AMERICAN PHENOLIC CORPORATION chicago 50

For more information circle **175** on inquiry card.

Jewel Bearings. New 4-page brochure presents description and diagrams of maker's synthetic sapphire or ruby jewel bearings.—Swiss American Jewel Bearing Co., 32-30 58th St., Woodside 2, L. I., N. Y.

Circle **628** on inquiry card.

Gaskets. New 8-page Bulletin TG-953 presents maker's "Chemiseal" gaskets and accessories for chemical-resistant piping and equipment.—United States Gasket Co., Camden 1, N. J.

Circle **629** on inquiry card.

Teflon Packing. New 14-page illustrated catalog presents maker's packing, gaskets, and tape.—Flexrock Co., Phila. 1, Pa.

Circle **630** on inquiry card.

Riveting, Drilling. New 48-page catalog presents maker's high-speed riveting, drilling, staking and wire-striping machines.—The High Speed Hammer Co., Inc., 313 Norton St., Rochester, N. Y.

Circle **631** on inquiry card.

Mechanical Differential. New 2-page bulletin presents features, speeds and specifications of maker's miniature mechanical differential—Ford Instrument Co., 31-10 Thomson Ave., L. I. C. 1, N. Y.

Circle **632** on inquiry card.

Miniature Clutches. New 4-page Catalog B-54 presents clutches which permit drive in one direction with free-wheeling action in opposite direction.—Miniclutch Co., 379 Morse St., Hamden, Conn.

Circle **633** on inquiry card.

Instrument Cabinets. New illustrated 2-page bulletin describes maker's line of "custom styled but production priced" instrument cabinets.—Elgin Metalformers Corp., 903 N. Liberty St., Elgin, Ill.

Circle **634** on inquiry card.

"Airbrasive" Unit. New 4-page Bulletin 5307 announces maker's "Model C" industrial "Airbrasive" unit, which provides a mixture of abrasive particles in a dry inert gas stream directed at work through a sintered tungsten carbide nozzle, producing precision cutting action.—S. S. White Dental Mfg., Co., 10 E. 40 St., New York, N. Y.

Circle **635** on inquiry card.

MATERIALS

Potting Compound. New 4-page issue of "Helix News" (Vol. 5 No. 1) features article on "Many uses for Helix Epoxy Based Compound."—Carl H. Briggs Co., 2255 Barry Ave., West Los Angeles, Calif.

Circle **636** on inquiry card.

Beryllium Copper Strip. New 8-page Bulletin 1 presents data for specifying beryllium copper precision strip. Includes available alloys, conditions, and temperatures.—Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

Circle **637** on inquiry card.

Extruded Plastics. New 10-page catalog describes and illustrates forms and applications of maker's line of extruded plastics.—Anchor Plastics Co., 36-36 36th St., L. I. C. 6, N. Y.

Circle **638** on inquiry card.

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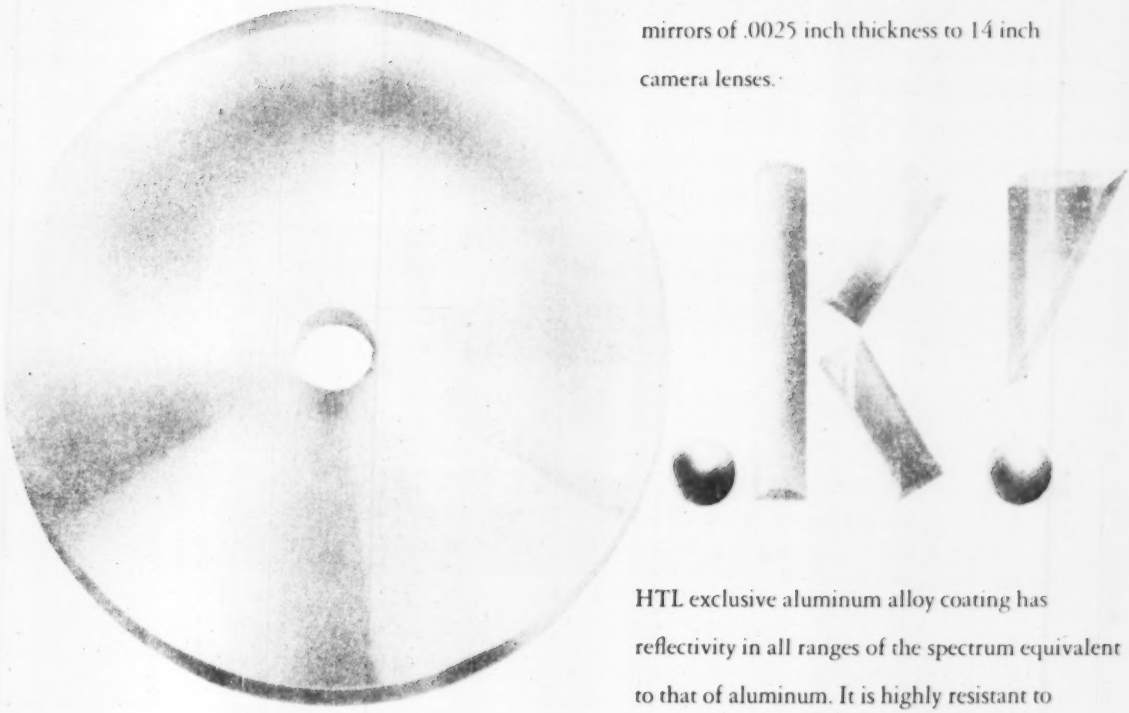

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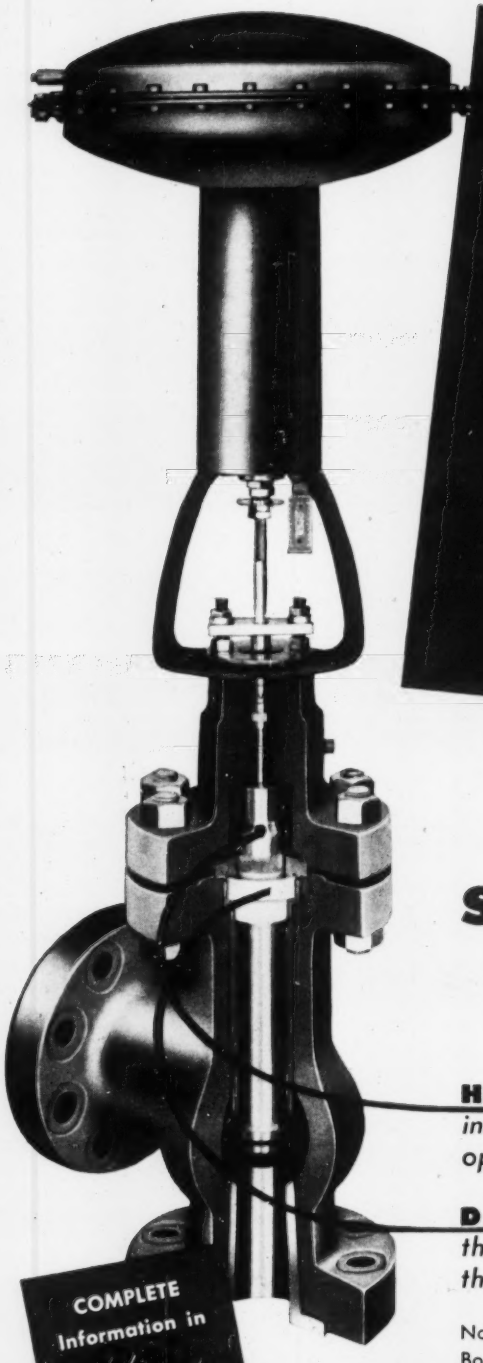

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